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(Editorial Secretary).

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PROCEEDINGS.

FIRST MEETING.

The first meeting of the Madras Literary Society and Auxiliary of the Royal Asiatic Society for the Sessions 1886-87 was held in the Theatre of the Government Central Museum at Madras on the 2nd December 1886, His Excellency Sir Mountstuart Grant Duff in the chair.

In opening the proceedings His Excellency said:—

"Ladies and Gentlemen,—I felt much honoured when I was asked to take the chair on this occasion, on which the famous Literary Society of Madras, returning to the ancient ways, is to hold its first meeting of the good old kind after a period of quiescence. And why should corporate bodies, as well as individual bodies, not have their periods of quiescence? 'He who sleeps doth not sin,' saith the true Russian proverb. The men who have taken most pains about this gathering are no rash innovators; they have even provided that it should take place not only on a Thursday, but on the first Thursday of the month, in terms of a Resolution of February 1844, and that the members might bring friends, according to the same Resolution. I am pleased, too, that the papers to be read this evening are neither exclusively literary nor exclusively scientific. Long ago, as far back as September 1833, the following passage was penned in the introduction to the first number of the Society's Journal:—'The great and well-deserved success that attended the journal of the Asiatic Society of Calcutta has pointed it out as a fit and appropriate model after which to found the Madras periodical which is about to be established under the auspices of the Literary Society and Auxiliary

of the Royal Asiatic Society. The work in question will not, however, be confined to papers drawn from the archives of the Society; nor is it intended to be restricted to elaborate essays or scientific disquisitions, but will be open to communications of a less formal nature upon every subject tending to afford useful information in regard to the people and country of India. It is evident indeed that the work cannot prosper if dependent alone on the limited stores of the Society, and it must mainly depend for success upon the support it may receive from the community at large, who will find in it a ready vehicle for conveying to the world the result of their discoveries, researches and observations, in all that relates to the literature, arts, sciences, natural history, &c., &c., of this country.' That is, as it should be. As in education, so in life, literature and science should be kept together, and neither of them allowed to oust her sister from a fair share of attention. It is important, too, to observe that this is a Society for the whole Presidency in its widest sense, and that assistance is invoked of all friends to literature and science through the whole of South India, whether European or Native. A great deal has already been done to make this country better known to the Western world; still an immense amount of work remains to be done, and we who really care about India require—now more than ever before—the assistance of men of science and letters to preserve one of the most interesting countries in the world from the hands of the Bores!—from that thrice-accursed race who, led now by one wearisome creature, and now by another, keep prosing on platforms, or in books, or magazines, or where not, about what ought to be done in India, with the minimum of knowledge of the facts of India. How is it that India is a subject from which so many of the best men in London turn with loathing, while so many of the best men in Paris find it delightful? Just because the charm and poetry of the East have been drowned for the English reader in Serbonian bogs of financial and administrative chatter, exhilarating to no creature, while the only association which the educated Frenchman has with the land in which we live is with the stores

of attractive fact which it has added to the sum of human knowledge. Are all its stores of attractive fact worked out? Surely not! Did not Mr. Thurston go the other day to Paumban and return, if not exactly with a miraculous draught of fishes, at least with an all but miraculous draught of marine life? Does not Mr. Henderson report that on all sides he finds new and most remarkable forms amongst the groups to which he has given special attention? Has not Mr. Bourne added, after a few days' search, I think, as many as twenty-one new species of earth-worms to those already known? I see some of you smile at the earthworms, but I assure you they are becoming very serious personages. I once heard the greatest savant of our time—may I not say the Aristotle of the nineteenth century—the late Mr. Darwin—call out to another eminent man of science, 'I say, Lubbock! you antiquarians should respect the earth-worms. They have done more to preserve tesselated pavements than any other agency.' Even in botany, a department which has been longer worked, I suppose, in Madras than almost any other, Mr. Lawson, Mr. Gamble, and other of our friends have still many new worlds to conquer. But why should I go on? The thing is too clear to need demonstration. We want to bring all the observing power that can be applied either to art, to letters, or to science together, and to utilize it for the benefit of this old and very distinguished Society. Amongst the many striking mottoes of the later Middle Age, which were collected in a fascinating book by the Prussian statesman, Radowitz, there are few more applicable to the conduct of life than: '*Disce ut semper victurus, vive ut cras moriturus.*' But in our relations to India I would reverse the maxim, and say, '*Vive ut semper victurus, disce ut cras moriturus.*' By the last part of the maxim so amended I mean to imply that we should keep our minds open to every new fact and impression which this country can give us, just as we should do if we had suddenly landed on a soil which, like the volcanic island Ferdinanda, might, before we had done learning half its secrets, sink back into the depths of the sea."

The following papers were then read and are published in the present number of the journal:—

1. On the Pallas and Pallis, by G. Oppert, Esq., Ph.D.[1]
2. Hints to Coin-Collectors in Southern India, Part I., by Captain R. H. C. Tufnell.
3. On the reputed Suicide of Scorpions, by Alfred Gibbs Bourne, Esq., D.Sc.
4. Notes on the Cyclone of November 9th, 1886, by C. Michie Smith, Esq., B.Sc.

SECOND MEETING.

The second meeting of the society was held in the Old College Hall, Nungumbaukum, on Thursday, the 3rd February, Dr. David Duncan in the chair.

The following papers were read:—

1. Notes on the Madras species of Matuta, by J. R. Henderson, Esq., M.B.
2. The Cosmogony of the Veda, by the Rev. M. Phillips.
3. On Hindu Music, by E. Stradiot, Esq.

The above papers are published in the current issue of the journal, with the exception of Mr. Stradiot's, which has to be unavoidably kept over till the next issue.

Mr. A. G. Bourne, D.Sc., exhibited a male specimen of Mygale fasciata.

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[1] This paper is unavoidably postponed till a future number.

THIRD MEETING.

The third ordinary meeting of the society was held in the Reading Room of the Old College, Nungumbaukum, on the 16th March 1887, Mr. H. S. Thomas, M.C.S., F.L.S., F.Z.S., in the chair.

The following exhibits were laid on the table :—

By Mr. H. S. Thomas :

Trygon uarnak.
Avicula (Meleagrina) fucata.
Avicula margaritifera.
Ostrea edulis.
Turbinella rapa.
Fasciolaria trapezium.
Avicula vexillum.
Modiola sp.
Young pearl oysters.
Seed pearls.

Drawing of formation of shell of Avicula.
Do. of young Avicula fucata and Avicula vexillum.
Do. of the above magnified.

By Mr. E. Thurston :

Mollusc (called locally "Suram"), growing on coral from Tuticorin pearl bank.
Young pearl oysters growing on stem of Gorgonia.

Balistes mitis.
Tetrodon inermis.
Pseudoscarus rivulatus.
Platax teira.
Amphiprion sebæ.
Tetrodon margaritatus.
Chætodon auriga.
Pterois miles.
Ostracion nasus.
Do. turritus.
Diodon histrix.

Mr. C. Michie Smith read a paper by Mr. G. K. Winter on "A New Method of finding Factors: a contribution to the Theory of Numbers."

Mr. H. S. Thomas read a paper on "The Pearl Oyster of the Gulf of Manaar: Avicula (Meleagrina) fucata."

Mr. E. Thurston read a paper on "The Fish Fauna of Ráméswaram Island."

The above papers are published in the current issue of the journal.

Notes on the Cyclone of November 9th, 1886.

(BY C. MICHIE SMITH, ESQ., B.SC., F.R.A.S., F.R.S.E.)

(*Read 2nd December* 1886.)

THE cyclone which visited Madras on the 9th of November ought to be, and probably will be, studied in detail by some member of the Meteorological Department. But as we may probably have to wait for some years for the results of the investigation, it will not be out of place to give at once a summary of the main features of the storm, trusting to the only sources of information at present available—the reports published in the local papers, Mr. Pogson's note in the *Gazette*, the Daily Weather Reports, and private observations.

The history of a cyclone ought to begin long before the cyclone has shown itself as such, for much of the interest in a cyclone is connected with its mode of formation. The conditions which are now recognized as those antecedent to cyclones may be briefly summarized as follows:—(1) A decrease in the baric gradients over the Bay and in Northern India, which tends to produce an approximate uniformity of pressure over the whole or a portion of the Bay area and of the adjacent coast districts; [1] (2) the winds decrease in strength and the air motion in the coast districts and northern portions of the Bay is feeble, and variable in direction; (3) the conditions of temperature and humidity in the

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[1] See Eliot, *Indian Meteorological Memoirs*, Vol. II. Part IV., p. 427.

Bay and adjacent coast districts are usually very uniform. Bearing these conditions in mind let us turn to the Daily Weather Reports for a few days preceding the 9th November. In these we find that on the 1st of the month the highest barometric pressure in India was 30·071 inches at Sibsagar, and the lowest 29·910 inches at Karwar; on the 2nd the highest and lowest were 30·076 at Sibsagar and 29·927 at Colombo; and that fairly strong winds between north and east prevailed over most of India. By the 4th, however, the barometric gradient between north and south had decreased, and the weather throughout Madras was unsettled, with tolerably heavy rain. On the 5th a barometric minimum showed itself off the Coromandel Coast, and at Diamond Island the barometer was falling, with a brisk north-east wind and heavy rain. At Madras the barometer was oscillating considerably from day to day with, on the whole, a downward tendency. Next day's reports showed that these disturbed conditions were getting more strongly marked, and the minimum off the Coromandel Coast was better defined. On the 7th the Reporter was able to write: "A cyclonic storm of tolerably large dimensions is approaching the Coromandel Coast, and is influencing the direction of the winds over the whole of the Bay as well as in Central and Southern India." Information obtained from officers of ships that had come from Colombo showed that in the south of the Bay there was still a strong south-westerly air current bringing into the Bay the large quantities of moist air which are necessary for the development of a cyclone. On the 7th the barometer at Madras rose till about 4 P.M. when it began to fall rapidly. The Weather Report for the 8th—based on the 10 o'clock observations—stated that "the depression noted yesterday as existing over the Bay of Bengal off the Coromandel Coast has thus slightly intensified, and the centre of the storm has moved slowly towards the coast."

We may now turn to the cyclone itself which began to show itself distinctly at Madras on the afternoon of Monday the 8th. During Monday the sea became excessively rough, the waves at the end of the jetty measuring about 17 feet from trough to crest, and the surf breaking magnificently all along the beach. The barometer, which had been falling slowly since 4 P.M. on the 7th, began about noon to fall much faster. The wind, however, continued light but was gusty, blowing from the north-west. During the night the barometer continued to fall rapidly and the wind veered round to north-west by west returning to north-west at 5 o'clock on the 9th. The maximum velocity during the night was 30 miles between 5 A.M. and 6 A.M. After that the velocity fell off to 22 miles between 8 and 9 o'clock. It then steadily increased again till it reached 45 miles between noon and 1 P.M. This was the maximum recorded in an hour, but since the wind came, as in all cyclones, in gusts, the actual wind velocity must have frequently exceeded this. The heaviest gusts were about 1 P.M. when the barometer also reached its lowest point—29·251 inches (reduced). This is the lowest reading at the Observatory, but at the Christian College, which is about 3¼ miles from the Observatory, the lowest reading was 29·22 inches (corrected to the Observatory standard). If we take into account the position of the centre of the cyclone, this indicates a barometric gradient of rather more than one-hundredth of an inch to the mile. Assuming for the moment that this is correct and that the gradient did not increase towards the centre, and taking the distance of the centre from Madras as 42 miles, the pressure at the centre would have been 28·8. That it was really considerably less than this is evident from the Armeghon observations, to which we will refer presently. That the gradient at some distance from the centre was about 0·01 inch per mile is confirmed by comparing the readings at

10 A.M., and 1 P.M., and calculating the distances from the centre at these hours. Similarly we can take the Armeghon observations and calculate the gradient nearer the centre, this gives 0·016 inches as the average gradient per mile between two points 10 miles from the centre and 45 miles from the centre, which would indicate a gradient of 0·02 near the centre, and a reading at the centre of between 28·4 and 28·5, which, though by no means the lowest on record, is a very low reading.

In the above calculation several things have been assumed. One of these is that the cyclone was advancing at a speed of about 15 miles an hour. This is deduced from the position of the storm centre next day when, according to the Weather Report, it lay midway between Bellary and Karwar, at 10 A.M. Other observations confirm this result. The path of the centre after it reached the land is fairly well defined, and there seems no reason to suppose that it suffered much change of direction on passing from the sea to the land. The reports received from the lighthouse-keepers at Armeghon and Coromandel show that the centre passed somewhere between these two stations. The report from Armeghon is as follows :—

"At 5 A.M., on November 9th, the barometer was 29·83, with the wind at north-north-east and continued falling rapidly, till, at 2 P.M., it stood at 28·79, a reading so low as was never before recorded in this department. The wind at that hour veered to east, changing afterwards to south-east and south. The barometer at 2-15 began to rise, and the rising was as rapid as the fall; at 9 P.M. it was 29·80, with the wind to the south. Great damage was done to the lighthouse, a large portion of the plastering of the column having been blown off, and the buildings belonging to it were also much damaged. The sea rose so high that the water inundated the village, and stood nearly 2½ feet deep round the lighthouse and Superintendent's bungalow."

The following observations were made:—

Time.	Barometer.	Wind.	Remarks.
5 A.M.	29·83	N.N.E.	Blowing fresh.
6 ,,	29·80	N.N.E.	
7 ,,	29·76	N.N.E.	
8 ,,	29·68	N.N.E.	Blowing stronger.
9 ,,	29·63	N.N.E.	
10 ,,	29·59	N.N.E.	Lull 10 minutes followed by gale.
10-30 ,,	29·55	N.N.E.	
11 ,,	29·50	N.N.E.	Increasing in violence.
11-30 ,,	29·42	Veering to N.E.	
12 noon.	29·33	N.E.	
12-30 P.M.	29·12	N.E.	Blowing with terrific violence.
1 ,,	28·92	N.E.	
1-30 ,,	28·81	Veering to E.	
2 ,,	28·79	E.	
2-15 ,,	28·82	S.S.E.	
2-30 ,,	29·03	S.S.E.	
3 ,,	29·29	S.E.	
3-30 ,,	29·40	S.	
4 ,,	29·51	S.	Abating.
4-30 ,,	29·55	S.	Blowing fresh in gusts.
5 ,,	29·61	S.	
5-30 ,,	29·65	S.	
6 ,,	29·69	S.	
6-30 ,,	29·72	S.	Moderate wind in gusts.
7 ,,	29·75	S.	
8 ,,	29·80	S.	
8-30 ,,	29·80	S.	Lulled down to gentle breeze.
9 ,,	29·80	S.	
10 ,,	29·80	S.	

We have no means of knowing the barometer error exactly, but a comparison between the readings at Armeghon for 95 days from September to December and the readings made at Madras at the same time, shows that the readings of the Armeghon barometer are probably only about 0·01 inches too high.

The report from the Acting Superintendent of the Pulicat Lighthouse which Captain Taylor has kindly communicated is less complete, as no readings of the barometer are given, but it is of considerable interest. The following are the most important parts :—

"1. Wind and rain first began in a small way on Sunday the 7th and Monday the 8th instant. Weather looked very

suspicious, and sea very rough and the water from the sea was coming in—no storm wave. Blowing first north-east afterwards changed north-west and then direct west, after which changed to south and ceased at 4 P.M. for a time.

"2. On the 9th, Tuesday, the day of the storm, at 3 A.M. wind and rain commenced blowing north-west hard up to 12 o'clock in the day and changed direct west with greater force, surf extremely high and boisterous, and kept on with double force up to 4 o'clock when the wind changed to south and ceased at 4 o'clock P.M.

"3. A portion of the lighthouse plastering towards the north fell off, and the water was running down from some crevices in the signal lantern and ventilators in the column. The water standing ankle deep at the entrance between the two store-rooms; the light was maintained throughout the rains without interruption.

* * * *

"6. The line of buildings erected for the lascars and which was nearly completed also suffered much; large portion of the tiles were blown off and the plastering washed away and water standing on the floor.

"7. The Superintendent's bungalow has also suffered much; the tiles nearly throughout the bungalow were blown away, the greater portion falling in and damaging the furniture. The water standing on the ground floor of the house about a foot for several hours."

Thus, while at Armeghon the wind began to blow fresh from north-north-east and veered through east to south, at Pulicat the wind at 3 A.M. was north-west and it veered through west to south; so that Armeghon was to the north of the centre and Pulicat to the south. The centre of the storm seems to have been nearer to Armeghon than Pulicat, and on the whole the observations are best satisfied by supposing that it crossed the coast line some 10 miles south of Armeghon. This agrees very well with the position of greatest damage on the Madras Railway as given in the

following account, for which I am indebted to Mr. French, Resident Engineer in charge of that division of the line—

"At Arkónam the storm was not very violent and no damage of any consequence was done to the railway. The same remark applies to the portion of the line between Arkónam and Puttur. A traveller by the train could just perceive that a storm had passed, by looking at the number of trees that were blown down within sight of the railway line. After passing Puttur the wind appeared to have become more violent. The telegraph line was first affected; the insulators being actually lifted out of their sockets by the force of the wind alone. Close to Pudi station the telegraph line was completely blown down and several posts were broken, and from Pudi into Tirupati the railway telegraph was almost completely wrecked. The Government telegraph line on the opposite side of the railway line escaped by being protected by the railway bank. At $\frac{81}{2}$, half a pier on the up stream side of Soornamooky bridge (composed of 9 arches of 30 feet span) gave way on the evening of the 9th. From the top of the bridge the only indication given of the disappearance of half of the pier was a slight crack running across the ballast. The bridge was crossed by men on a trolly who fortunately noticed the crack as they passed over it, and they went back to examine the bridge. It was then found that a portion of the 6th pier had been carried away. All the arches remained in position until the night of the 10th, when a portion of the 6th arch fell in, and carried with it portions of the 7th and 8th arches and 7th and 8th piers. It was reported that four tanks breached in the Chandragherry taluk, and the sudden rush of water broke the bridge. The rainfall close to the railway was very light, and none of the small rivers had much water in them except what escaped from breached tanks.

"At Tirupati station the storm was most violent. All the zinc roofs were more or less damaged. The goods-shed, a building about 60′ × 30′, was completely stripped of its roof, and the zinc was blown 60 yards from the building. The station palings were blown flat upon the ground. Lamp posts, sun shades,

sentry boxes, and all description of light structures were knocked over and broken. The forest at Ballipalli suffered severely and a number of trees were blown across the telegraph wires. At Kodúr the goods-shed roof was blown off, and a number of trees were blown down. At Rajampet and Nandalúr the goods-shed roofs were damaged. The storm did not appear to extend further north than Nandalúr, for at Cuddapah no damage was done."

It will be noticed that the actual breaching of the Madras Railway, which was by far the most serious damage done by the storm, was caused by the bursting of several tanks. These tanks gave way apparently not on account of heavy rainfall, but through the pressure of the wind heaping up the water, as in the case of the Red Hills tank on November 21st, 1884. In Madras itself the damage done was comparatively slight, but many hundreds of trees were uprooted, and the sea washed away a considerable part of the road near the Rayapuram Railway station.

The following are the observations made by Mr. Pogson at the Observatory during the storm :—

Hourly Records of Pressure, Wind, and Rain during the Cyclone.

Time.	Reduced Barometer.	Wind Direction.	Wind Velocity.	Rain.
	INCHES.	POINTS.	MILES.	INCHES.
Nov. 8th—				
10 P.M.	29·660	N.W.	15	..
11 ,, ...	29·659	N.W.	22	..
Midnight.. ..	29·626	N.W.	18	0·08
Nov. 9th—				
1 A.M.	29·589	N.W. by W.	21	0·12
2 ,, ...	29·566	N.W. by W.	17	0·17
3 ,, ...	29·544	N.W. by W.	20	0·09
4 ,, ...	29·533	N.W. by W.	24	..
5 ,, ...	29·515	N.W.	30	0·05
6 ,, ...	29·521	N.W.	27	0·02
7 ,, ...	29·527	N.W. by W.	26	0·10
8 ,, ...	29·530	W.N.W.	22	0·54
9 ,, ...	29·520	W. by N.	25	0·36

Time.	Reduced Barometer.	Wind Direction.	Wind Velocity.	Rain.
	INCHES.	POINTS.	MILES.	INCHES.
Nov. 9th—*cont.*				
10 A.M.	29·446	W.	27	0·64
11 ,, ...	29·374	W.S.W.	36	0·28
Noon	29·293	S.W. by W.	45	0·24
1 P.M.	29·251	S.W. by W.	40	0·07
2 ,, ...	29·277	S.S.W.	36	0·04
3 ,, ...	29·331	S. by W.	31	0·08
4 ,, ...	29·410	S.	23	0·02
5 ,, ...	29·483	S. by E.	21	..
6 ,, ...	29·538	S. by E.	19	..
10 ,, ...	29·687	S. by E.	11	..

The subsequent history of the storm is of special interest. At 10 o'clock on the 10th its centre lay about half way between Bellary and Karwar, and before next morning it had passed into the Arabian Sea. In passing over the land the depression seems to have been partly filled up, but on again coming over the sea it regained its former extent, and crossed the Arabian Sea as a very violent storm. The only information regarding this part of its course at present available is contained in a letter to the *Bombay Gazette* by one of the passengers in the P. and O. Steamer *Peshawar* and accounts since published of the voyages of the S.S. *Mobile* and *Henry Bolckow*. The first signs of it were met at noon on Friday the 12th in lat. 15° 39′ N., long. 57° 19′ E. At noon next day the *Peshawar* was 614 miles from Bombay. At this time the wind and sea were both threatening and the ship's course was changed to north-west. By 4 P.M. there was a "furious" gale and the barometer continued falling till 10-30 P.M. when it reached its minimum, 29·37 inches. The worst part of the storm was passed by 4 A.M. on the 14th. The wind veered from north through east to south-east. The distance of the ship from the centre was estimated at 40 miles. The actual position of the ship at this time is not given, but we know it near enough to show that the path

of the storm centre was nearly a straight line from where it struck the east coast to its position on the 13th, this line being in a direction west 14° north, and crossing the west coast about half way between Karwar and Goa. The S.S. *Mobile* met the storm on the 15th. At 9 P.M. on that day it must have been very near the centre, for the barometer fell to 29·15 inches. The ship was then in lat. 23° 36′ N., long. 62° 10′ E., and, since the wind backed from the east to the north, the centre was to the north of the ship. This shows that the path of the cyclone had been entirely changed, and that the centre was then moving nearly due north. The *Henry Bolckow* at noon on the 15th was in lat. 23° 30′ N., long. 61° 54′ E., and had the wind south-east. At 4-30 P.M. the barometer reached its lowest point, 29·32 inches, and the wind was now in the north-east. At 6 P.M. the ship was midway between Ras-al-had and Gwetter. The wind shifted to west then to north-north-west, and by 8 P.M. the weather was quite clear.

Of the rainfall during the storm I have not been able to get any details. Certainly it cannot have been excessive, for the rainfall for the whole month was nowhere much above ten inches in the districts affected.[2] It is much to be regretted that more detailed information on this head is not available.

There are several points of special interest concerning this storm. The barometric depression was exceptionally great. On this point Mr. Pogson remarks in the *Gazette:* "It is probable that the centre landed somewhere between the latitudes of Nellore and Ongole, and that it was, near its central path, one of the heaviest storms that has visited this Presidency next after those of 30th October 1836 (when

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[2] A gentleman present at the meeting at which the paper was read stated that the rainfall increased from about 3 inches near Ennore to about 10 inches near Pulicat.

the barometer fell to 28·285), 16th May 1841, and 25th November 1846." To these Madras storms we may add the storm of 3rd June 1842, the centre of which passed over Calcutta, and which was recorded as the most severe gale ever felt there, when the barometer fell to 28·278; the storm of 5th October 1864, when the centre passed over Contai and the pressure fell to 28·083; and the cyclone of September 22nd, 1885, when the barometer at False Point, over which the central calm passed, fell to 27·135 (reduced)—probably the lowest well authenticated reading ever taken.

Another point of considerable importance is its having crossed the Peninsula without breaking up. The majority of the storms of the south-west monsoon pass over the Orissa hills into the Central Provinces, and a small proportion advance across the head of the peninsula into the northern districts of the Bombay Presidency, but it is otherwise later in the year. In fact, Eliot says: "storms march across the peninsula during the intermediate period, and when both monsoon currents are fully established, *i.e.*, in July, August, and the early portion of September." [3] Eliot further accounts for this difference by showing that as a rule storms of the transition period are of low elevation, while those of the intermediate period are of high elevation, so that they are less affected by coming in contact with hills. The cyclone under discussion must then have been one of greater elevation than usual, but its course was probably also facilitated by the path which it was following.

It is now pretty generally accepted that the old rule for finding the direction of the centre of a cyclone from the direction of the wind is very far from the truth, but it may still be of interest to point out that in this particular case

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[3] *Loc. cit.*, p. 437.

the angle between the wind direction and a line drawn to the centre of the cyclone varied from about 120° to 135°.

The accompanying sketch map will show roughly the path of the cyclone, and the isobars at 10 A.M. on the 9th November.

On a New Method of finding the Factors of any given Number:

A contribution to the Theory of Numbers.

(By G. K. WINTER, M.I.C.E., F.R.A.S.)

In the first volume of Stanley Jevons' Principles of Science, page 141, the author gives a pretty illustration of the greater difficulty of inverse processes as compared with direct ones, and this illustration is given in the following words :—

"The same difficulty arises in many scientific processes. Given any two numbers, we may by a simple and infallible process obtain their product, but it is quite another matter when a large number is given to determine its factors. Can the reader say what two numbers multiplied together will produce the number 8,616,460,799 ? I think it unlikely that any one but myself will ever know, for they are two large prime numbers, and can only be rediscovered by trying in succession a long series of prime divisors until the right one be fallen upon. The work would probably occupy a good computer for many weeks, but it did not occupy me many minutes to multiply the two factors together."

The secret of these numbers probably died with him, and their rediscovery possesses a certain interest, which will be readily appreciated. Apart from this, however, the resolution of a number into factors by any means other than by direct trial, has, as far as I am aware, not hitherto been done, and, if I am right in this, I think the method by means of which these numbers have been rediscovered may possess some theoretical value.

Every number is either odd or may be reduced to an odd number by repeated division by two, and therefore, in dealing

with this question, we take it for granted that the number, whose factors are required, is odd.

It is first necessary to show that every odd composite number is of the form $x^2 - y^2$, that is, it is the difference between two squares (the proposition is general, but we need only here deal with odd composite numbers).

Let a be a given odd composite number, and m and n a pair of its factors, so that $a = m \times n$.

a being odd, all its factors are odd, so that m and n are odd.

$$\text{Let } \frac{m+n}{2} = x \text{ and } \frac{m-n}{2} = y.$$

Note.—It is evident that both x and y are whole numbers, because, m and n being both odd, their sum and their difference are both even.

$$\text{Then } \frac{m+n}{2} + \frac{m-n}{2} = m = x + y,$$

$$\text{and } \frac{m+n}{2} - \frac{m-n}{2} = n = x - y.$$

Therefore $a = m \times n = (x + y)(x - y) = x^2 - y^2$.

The problem of finding the two factors m and n, therefore, resolves itself into finding the integral values of x and y in the following indeterminate equation, namely,

$$a = x^2 - y^2,$$

which we may write in the more convenient form of

$$y^2 = x^2 - a.$$

In other words, we have to find a square number x^2, such that, if, after subtracting from it the given number a, we get a square number for a remainder, then this remainder will equal y^2; and one integral solution of our equation will have been found. The factors will then be $x + y$ and $x - y$.

There is, I believe, no direct way of solving this equation, but the following method will enable us to arrive at the solution without any large amount of labor.

It is evident that x must be either equal to, or greater than $\sqrt{a}$. If a is a complete square then $x^2 = a$ and $y^2 = 0$. One pair of factors being in this case $\sqrt{a}$ and $\sqrt{a}$; but if a is not a complete square we take the next whole number above $\sqrt{a}$ and call it b.

Square b and deduct a, that is, deduct a from the next square above the given number.

Then if b^2-a is a complete square we have $\sqrt{b^2-a} = y$ and $b = x$.

If $b^2 - a$ is not a complete square we try $(b + 1)^2 - a$, $(b + 2)^2 - a$, and so on, until we find a remainder, that is, a square.

Let $b^2 - a = c$.

Now if we were obliged to square successively b, $b + 1$, $b + 2$, &c., and deduct a from each, the process would be long and troublesome.

Fortunately there is no need for this, because $(b + 1)^2$ is greater than b^2 by $2b+1$, therefore $(b+1)^2-a = c + (2b+1)$; and $(b+2)^2$ is greater than $(b+1)^2$ by $2\ (b+1)+1 = 2b+3$, therefore $(b+2)^2-a = c + (2b+1) + (2b+3)$ and so on; so that we get the series of differences we require by adding $2b+1$, $2b+3$, $2b+5$ and so on to the first difference. Each being added to the sum of all that precede it.

The next operation is to test these differences to see if any are perfect squares.

In doing this we are first helped by the fact that all squares are of the form $5\ x$ or $5\ x \pm 1$, so that we may reject all numbers ending with the figures 2, 3, 7, 8, and to these may be added 0, unless there are two, as all square ending in 0 must be multiples of 100.

Again all squares are of the form $4\ n$ or $4\ n + 1$. In applying this test, we need only look at the last two figures. If the last figure but one be even, then, for the number to be a multiple of four, the last figure must be 0, 4, or 8; therefore

in such a case, the possible squares must end in either 1, 4, 5, 9, or 0. 0 we have dealt with above. If the last figure but one be odd, then to be a multiple of four, the number must end with either 2 or 6, so that in this case we can only have 6 as a possible square, and we may reject all numbers ending with any other figure.

If the last figure be a 5, the last figure but one will be 2 if the number is a square, for every square number ending with 5 is divisible by 25, and we have already seen that if the last number is 5, the last figure but one must be an even number, so that the last two figures cannot be 75. If the last figure therefore be 5, we may reject it unless the last but one is 2.

No square number has its last two figures the same, unless they be 00 or 44; and if the number ends with a 0, it cannot be a square unless the number of cyphers is even.

We are further helped by another criterion suggested by Professor Michie Smith depending on the last figure.

Suppose the last figure of a is 9, then 9 can be produced as a last figure by 1×9, 3×3, or 7×7, but by no others. So that the factors must have one or other of these pairs of figures as their last figures, and it is easy to see whether any possible root of a number can end in a figure such that, when added to and subtracted from the corresponding value of x, it will produce numbers having either of these pairs of figures as their final figures. In this way we may generally reject many of the differences which are possible squares, and only go through the process of extracting the square root in those cases in which the necessary conditions are present.

By using this method a trained computor would discover the two factors of the number given by Jevons in half an hour instead of many weeks.

The number given by Jevons is 8,616,460,799. We first take the square root of the given number. This is found to

be 92824 with a remainder; the next number is therefore 92825, and the square of this is 8,616,480,625.

The difference between this and the given number is 19826, which we see at once is not a square number, as 6 is the last figure, and the last figure but one is not odd.

We then proceed as follows :—

19826			
185651	add $(2 \times 92825)+1$		
205477	This is the difference between the given number and 92826^2		
185653	add $(2 \times 92825)+3$ or 185651 + 2.		
391130	This is the difference between the given number and 92827^2		
185655			
576785	Do.	do.	92828^2
185657			
762442	Do.	do.	92829^2
185659			
948101 *	Do.	do.	92830^2
185661			
1133762	Do.	do.	92831^2
185663			
1319425 *	Do.	do.	92832^2
185665			
1505090	Do.	do.	92833^2
185667			
1690757	Do.	do.	92834^2
185669			

1876426	This is the difference between the given number and 92835^2		
185671			
2062097	Do.	do.	92836^2
185673			
2247770	Do.	do.	92837^2
185675			
2433445	Do.	do.	92838^2
185677			
2619122	Do.	do.	92839^2

* * * * *

and so on, the number added being increased by 2 each time.

The possible squares, of which there are only two in the above fifteen differences, are marked *.

In this way it is found that the first difference which is a complete square is the number 10233601, and its square root is 3199. This last number added to and subtracted from 92880 (which is the number whose square, minus the given number, is the square number 10,233,601, found as above) will give the numbers 96,079 and 89,681, which are the required factors.

Having found two factors as above, we can go on and test for others in the same way; but it will be found easier to treat each of the factors themselves in the same way as we have treated the original number. In the present case, however, the factors 96,079 and 89,681 we know are prime numbers, and further trial is of course unnecessary.

The following reasoning, which first led me to the method described, may be interesting:—

Let us suppose that the number we are dealing with is odd. Then all its factors must be odd, and therefore between any pair of its factors there must be a middle integral number. Let this be x for a certain pair of factors, then

let y be the difference between this middle number and each of these factors, so that the factors themselves are $x + y$ and $x - y$. Then the number itself which we will call a will be $(x + y)(x - y) = x^2 - y^2$. That is to say, it will be less than the square of the middle number by the square of the difference between the middle number and either of the factors. To illustrate this, let us take the number 10 and suppose it to be a middle number between certain pairs of factors equally distant from 10.

—	Difference between 100 and each product.	Square root of ditto.	Difference between 10 and each factor.
$10 \times 10 = 100$ ..	..	..	..
$9 \times 11 = 99$ ..	1	1	1
$8 \times 12 = 96$ ..	4	2	2
$7 \times 13 = 91$ ..	9	3	3
$6 \times 14 = 84$ ..	16	4	4
$5 \times 15 = 75$ ..	25	5	5

and so on.

It is evident at once that $(x + y)(x - y)$ or $x^2 - y^2$ is less than x^2 for all values of y. In other words, unless a, the given number, is a perfect square, in which case the factors are each of them $\sqrt{a}$, the middle number must be greater than $\sqrt{a}$, for the product of all numbers equally distant from $\sqrt{a}$ is of course less than a. Our first process therefore is to take the square root of a, and if this is not a perfect square, we take the next integral number above $\sqrt{a}$; let this be b.

We then square b and deduct a. Then, if $b^2 - a$ be a perfect square, we know at once that b is the middle number of the factors, and $\sqrt{b^2 - a}$ is the difference between this middle number and each of the factors. Let us take an example:—

Let the number be 45. The square root of this is 6 +, and the next higher number is 7. The square of this is 49, and

$49 - 45$ is 4, which we see at once is a square number. We know, therefore, that 7 is the middle, and that $\sqrt{4} = 2$ is the difference between the middle number and the factors; thus one factor is $7 + 2 = 9$ and the other is $7 - 2 = 5$. In the above case the difference 4 between a and b^2 was a perfect square, and the solution was found at once; but now let $a = 39$ then $b^2 - a = 10$ which is not a square number. The middle number must be greater than 7. Take 8 the next number. The square of 8 is 64, and $64 - 39 = 25$, which is a square number, therefore 8 is the middle number, and the difference between the middle number and each factors is $\sqrt{25} = 5$; the factors are therefore $8 + 5 = 13$ and $8 - 5 = 3$.

It has been pointed out to me that every odd number may be expressed as the difference between two squares. This is of course quite true, for $a = \left(\frac{a+1}{2}\right)^2 - \left(\frac{a-1}{2}\right)^2$. This merely indicates that one pair of factors is a and 1. In the order in which the factors are found by the process described, this solution would be found last; and, if no other solution be found, the number must be prime. This consideration shows that the operation need not be carried beyond finding the difference $\left(\frac{a+1}{2}\right)^2 - a$.

If a table of squares is available, the actual subtractions may be performed, rejecting in the process all those squares which have the last two figures such that, after the subtraction, the differences could not be squares. The process would in this way be somewhat similar to that used for testing numbers of the form $4n + 1$ for primes. Such numbers are prime when they are the sum of two squares, but only of two.

The Fish Fauna of Rámésweram Island.

(By EDGAR THURSTON, Esq., *Superintendent, Government Central Museum, Madras.*)

I MAY state at the outset that I have no new facts to add to the subject of South Indian Ichthyology, and my only excuse for reading the present notes before the Society is that the fish fauna of the coral reefs of Rámésweram—an island separated on the one hand from the Indian continent, and on the other from the island of Manaar, by an interrupted ridge of rocks known as Adam's bridge—stands out in such striking contrast to that of other places on the Madras coast, as to be, in some measure, instructive.

The following list is a complete one of the fishes obtained during a residence of three weeks on Rámésweram island in the month of August 1886 :—

SUB-CLASS. PALÆICHTHYES.

FAMILY. TORPEDINIDÆ (Electrical rays).

Narcine timlei.

SUB-CLASS. TELEOSTEI.

Leptocephalus, sp.

FAMILY. PERCIDÆ (Perches).

Lates calcarifer.
Lutianus fulviflamma.
Diagramma crassispinum.
Scolopsis vosmeri.
* *Apogon kalosoma.*
Cheilodipterus quinquelineatus.

FAMILY. SQUAMIPINNES.

* *Chætodon auriga.*
* *Do.* sp.
* *Do.* sp.
* *Heniochus macrolepidotus.*

FAMILY. MULLIDÆ (Red mullets).

Upeneoides tragula.
Upeneus Indicus.

FAMILY. SPARIDÆ (Sea breams).

Pimelepterus cinerascens.

FAMILY. SCORPÆNIDÆ.

* *Pterois miles.*

FAMILY. TEUTHIDÆ.

Teuthis oramin.

FAMILY. BERYCIDÆ.

Holocentrum rubrum.

FAMILY. ACRONURIDÆ (Sturgeons).

* *Acanthurus mata.*
Do. sp.

FAMILY. CARANGIDÆ (Horse-mackerels).

Caranx gallus.
Platax teira (vel *vespertilio*).
Lactarius delicatulus.

FAMILY. SCOMBRIDÆ (Mackerels).

Echeneis naucrates.

FAMILY. GOBIIDÆ (Gobies).

Periophthalmus Koelkreuteri.

FAMILY. CENTRISCIDÆ.

Amphisile scutata.

FAMILY. POMACENTRIDÆ.

* *Glyphidodon cœlestinus.*
* *Do. notatus.*

FAMILY. LABRIDÆ (Wrasses).

* *Platyglossus Dussumieri.*
* *Pseudoscarus chrysopoma.*
* *Do. rivulatus.*
* *Amphiprion Sebæ.*

FAMILY. PLEURONECTIDÆ (Flat fishes).

Plagusia marmorata.
Do. sp.

FAMILY. SCOPELIDÆ.

Saurida tumbil.

FAMILY. CLUPEIDÆ (Herrings).

Pellona Leschenhaultii.

FAMILY. MURÆNIDÆ (Eels).

Muræna tessellata.
Do. sp.

FAMILY. SYNGNATHIDÆ.

Syngnathus serratus.

FAMILY. SCLERODERMI.

Balistes mitis.
Triacanthus strigilifer.
Ostracion cornutus.
Do. nasus.
Do. turritus.

FAMILY. GYMNODONTES.

* *Tetrodon margaritiferus.*
Diodon hystrix.

An examination of the above list shows in a very marked manner the prevalence of the so-called "coral fishes,"[1] *i.e.*, brightly colored fishes—*Chœtodon*, *Platyglossus*, *Heniochus*, *Pseudoscarus*, &c.—which abound round the reefs, and feed either on the small delicate marine Invertebrata which swarm on the living corals or, if their teeth are adapted for the purpose, on the hard calcareous substance of the corals.

As stated by Hæckel,[2] an explanation of the bright coloring of the fishes is found in the Darwinian principle that "the less the predominant coloring of any creature varies from that of its surroundings, the less will it be seen by its foes, the more easily can it steal upon its prey, and the more it is fitted for the struggle for existence."

Conspicuous by their abundance were several species belonging to the family Sclerodermi, including *Balistes* (file fish), whose jaws are armed with teeth well suited for breaking off pieces of hard coral, or boring holes into the shells of the mollusca, on the soft parts of which they feed.

The file fishes are said [3] to destroy an immense number of mollusks, thus becoming most injurious to the pearl fisheries.

Present, too, in great numbers, were several species of the family Gymnodontes: *Tetrodons* (globe fishes), including the beautifully marked little *Tetrodon margaritiferus*, and *Diodons*, which have a very bad reputation among the natives as being very poisonous.

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[1] Indicated by an asterisk.
[2] *A Visit to Ceylon*, 1883, pp. 185-6.
[3] Günther. *Study of Fishes*, 1880, p. 685.

On the reputed Suicide of Scorpions.

(By ALFRED GIBBS BOURNE, D.Sc., F.L.S., C.M.Z.S.,
Fellow, University College, London, and Madras University).

The statement that a scorpion will under certain circumstances, as when surrounded by a circle of red-hot embers, or when exposed to the rays of the sun concentrated by a burning glass, deliberately sting itself and thereby cause its own death, has been made by several well-known observers. Other observers have, however, repeatedly subjected scorpions to a great variety of tortures, and have been unable in any instance to persuade the victim to commit suicide.

In a communication recently made to the Royal Society of London,[1] I have reviewed in detail the evidence which has been put forward on both sides of the question; it is therefore unnecessary that I should do so here.

Romanes[2] has pointed out how remarkable it would be to find any animal possessing "an instinct detrimental alike to the individual and to the species." It might have been, in the face of various positive statements that suicide was committed, exceedingly difficult to prove that it was not. There is, however, one mode of attacking the question which does not seem to have occurred to any one who has hitherto attempted to refute the statements, viz., to examine the *possibility* of a scorpion being injured by its own poison. I have repeatedly tried a variety of experiments with this end in view, and I find that the poison of one scorpion has little, if any, influence either upon itself or upon another scorpion. It is therefore quite impossible for a scorpion to sting itself to death. I was led to suspect that this would be the case

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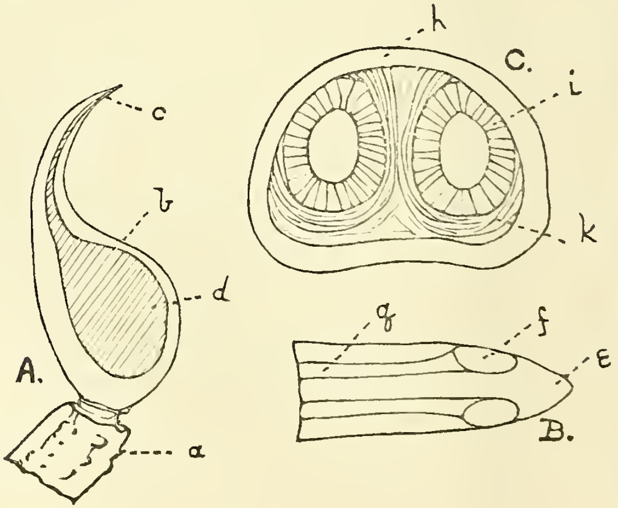
[1] Read January 13, 1887. [2] *Animal Intelligence*, p. 225.

from a consideration of Fayrer's experiments upon poisonous snakes. He has conclusively shown that a colubrine snake is "immune" from the poison of a colubrine snake and a viperine from that of a viperine snake, and as it seems probable that the poison of scorpions owes its activity to the presence of one of the same class of bodies—ptomaines—as the snake poison does, one might naturally expect to find that a scorpion was immune from its own poison and one scorpion from that of another; this, as I have stated above, experiment has shown to be the case.

The arrangement of the poison glands in a scorpion has never been described in detail. Some years ago I made out this arrangement in *Euscorpius italicus*, but have not hitherto published my observations.[3]

The poison gland is double, and each gland is invested by a powerful muscle, the contraction of which expels the poisonous secretion.



[3] E. Ray Lankester, *Journ. Linnean Soc.*, Vol. XVI, p. 457, *footnote*.

In the woodcut, fig. A, the post-anal "sting," is shown as though its wall were transparent, *a* is the last tail somite, *b* the post-anal "sting," *d* marks the position occupied by the poison sac of one side (that of the other side is not shown). The sacs have each a narrow duct, and the ducts open on the dorsal surface at some little distance from the actual point of the sting as shown in fig. B; fig. C. represents a section through *x y* (fig. A). The glands of the right and left sides, *i*, are seen each invested by its muscular coat *k*. By taking hold of the "sting" with a pair of forceps all the poison can be forced out from the apertures (fig. B, *f*). When I have wished to sting an animal, I have taken hold of the sting in this manner and, after inserting the point, have squeezed it, a method which when applied to animals affected by the scorpion poison has always proved effective.

My experiments and observations fall under the following heads:—

Series A.—Scorpions made to sting themselves.
,, B.—Scorpions made to sting other scorpions.
,, C.—Scorpions made to sting various other animals with the view of ascertaining the action of the poison on these animals and of demonstrating that the method of stinging employed was effective.
,, D.—Observations on scorpions stinging one another during a fight.
,, E.—Experiments to explain statements of previous observers.

Series A.—I have repeatedly taken hold of the sting of a scorpion in the manner described above, and having inserted the point into some part of the body, either between two terga or between the terga and sterna, or into a joint in the leg, have then squeezed out the poison, but the scorpion has

never been injured by it, and I have kept such scorpions for days afterwards in a perfectly lively and healthy condition.

Series B.—I have carried out an equally large number of experiments, using one scorpion to sting another, and, as before, in no case was there any injurious effect.

Series C.—These were commenced to test the efficacy of my method of stinging. I stung a small frog in the thigh. There was a marked general effect, the frog was very quiet for some time and seemed to avoid using the limb stung, but quite recovered in a few hours. A chicken was stung in the thigh which evidently caused it great inconvenience, it hopped about on one leg for half-an-hour and then crouched down apparently very uneasy, but it got up from time to time, and in about an hour or so was ready to feed. The next morning it seemed perfectly well, but cried out violently when brought near a scorpion. I tried a simple puncture experiment on another chicken to show that the effect was not due to a mere puncture, which seemed to have very little effect. I have constantly given these two chickens dead scorpions to eat, which they do greedily. On one occasion I gave them a living scorpion, which they attacked, but one of them got stung near the root of the beak; it was ill for some hours; its symptoms were similar to those mentioned above. It is evident that under ordinary circumstances a scorpion's sting is not fatal to a chicken.

I next tried various insects. A cockroach stung between the thoracic terga becomes almost instantly paralysed, a mere puncture made in the same place has little or no effect. The cockroach does not generally die until some time afterwards. I have seen a cockroach lie on his back after being stung, just twitching his legs and maxillæ, and remain alive for 24 hours.

I procured some large locusts and stung them in the thigh of one of the third pair of legs, that leg instantly becomes paralysed and the animal moves about on the

other five legs, dragging the stung leg behind it, or often holding it straight up in the air. If these stung individuals are kept, they usually after a time drop the stung leg altogether, and appear perfectly well afterwards.

The scorpion's sting appears to have a similar but more rapid effect upon spiders.

I have also been able to procure one *Galcodes* and two *Thelyphonus*, both very near allies of the scorpion, and they all succumbed almost instantaneously; death occurred within a few seconds.

These series of experiments show that the scorpion is immune from its own poison, but that insects generally and other Arachnida are very sensitive to it.

Two questions now presented themselves. The scorpion is undoubtedly a cannibal, how does it kill its prey? Further, how can we explain the statements that scorpions do commit suicide?

Series D.—On several occasions I watched two scorpions fighting. They face one another, and each tries to get his chelæ outside the other's chelæ and so hold him a prisoner; then they sting one another repeatedly; but the stinging seems to have no effect, and if the scorpions are at all equally matched this may go on for a long time. I watched one pair fighting on and off for a couple of days, but at last one overpowers the other, and holding him by the chelæ uses his chelicerœ to actually tear out those of his opponent; this he eventually succeeds in doing, and as soon as he makes a wound proceeds to suck the juices. The victim succumbs to main force and not to any poisoning.

Series E.—It is always difficult to account for the manner in which mistakes may arise. Any statement that a scorpion ever committed suicide by stinging himself to death I cannot but believe to be a mistake. I think that I am however able to explain Dr. Bidie's observations, which are perhaps the best authenticated of all the alleged cases of suicide and are

certainly the best known in Madras. I have frequently noticed that when a scorpion is made very uncomfortable in any way, as in a bottle with chloroform vapour, or when held in the sun, or under a burning glass, that it lashes about with its tail, and that so violently that the sting might easily catch under the edge of a tergite or elsewhere, giving all the appearance of an intentionally inflicted sting. Further, and this is certainly a very curious fact, a scorpion will die or at any rate enter into a perfectly passive insensible state in from 5 to 15 minutes if kept in the sun, and still more rapidly if held under a burning glass.

If a scorpion is placed in an ordinary white pie-dish and left in the sun, it will soon rush violently about, lash its tail, and then, sometimes quite suddenly, draw its legs up and become perfectly quiet; if then removed into the shade, it will recover in half-an-hour or so, but if left longer in the sun it will die. In one experiment I placed a thermometer in the pie-dish with the scorpion, and when the latter died the thermometer marked only 104° F. I have very little doubt that the scorpion observed by Dr. Bidie died from the effect of the sun, although it may have stung itself or appeared to do so accidentally. I have on one occasion observed a scorpion placed in the sun as described above, extrude a droplet of poison from its sting without inserting the point anywhere.

To sum up, we may say then, that a scorpion is "immune" from its own poison and from that of other scorpions, and that scorpion poison is most marked in its action upon animals belonging to groups nearly allied to the scorpion.

It would be exceedingly interesting to determine the reason of this immunity of a snake or scorpion from the effects of its own poison. Dr. Nicholson [4] has expressed the

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[4] *Indian Snakes*, 2nd edition, p. 148.

opinion that a gradual innoculation of cobra poison would produce an immunity from its effects, and states that Dr. Shortt has tried the experiment with a dog with little success, but the experiment was irregularly carried out and needs careful repetition. There is here, I believe, a probable explanation. The cells of the poison gland secrete the poison from the blood, *i.e.*, they build up the poison from the nutritive matter furnished by the blood. Some of this poison may become absorbed into the blood, and there are possibly, always, small quantities of the poison in the blood, thus a constant but very gradual innoculation is taking place, resulting in complete immunity. Professor Ray Lankester has recently suggested this to me in a letter, and has further pointed out that we have here something similar to the immunity of Pasteur's dogs from hydrophobia.

I have endeavoured to discover minimal amounts of poison in the scorpion's blood by injecting it into insects, but am unable to produce any effect. It will be interesting to try this with the much more virulent poison of the cobra, but this and other experiments I have been obliged to defer for the present. I may add here that I shall be exceedingly obliged to any one who will send me any observations upon the habits of the scorpions, or living specimens of the various kinds of scorpions in any district, more expecially the so-called water scorpion which I am particularly anxious to procure.

Specimen page from Numismatic Note-book.

Date.	Place.	Metal.	Weight.	Type.	Description and inscription.		Number in cabinet.	Reference.
					Obverse.	Reverse.		
1885.			GRS.					
Nov. 12	Bangaloro.	C.	..	Mysore (M)	Elephant with letter ب above.	ضرب پٹن	256	Hawkes' Mysore Coins.
Do.	Do. ..	G.	52	Mysore ..	Hyder's initial ح	Siva and Parvati with trisul and doer.	270	Do.
Dec. 10	Madura ..	S.C.	54	Pathan ..	غياث الدنيا والدين Ghias-ud-din Tughlak Shah.	تغلق شاه السلطان ابوالعظفر	2206	Thomas' Chronicles, No. 164.
..	Do. ..	C.	..	Pandyan (?)	Lingam on bull ..	Two figures [Siva and Parvati (?)].	..	..

Hints to Coin-Collectors in Southern India.

Part I.

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There are few more fascinating pursuits to be enjoyed by the "dweller in a foreign land" such as India, than the collecting of those records of a bygone age, which, in the form of coins or inscriptions, carry us back beyond the reach of history to ancient times, when kings and dynasties ruled, whose very names are almost unknown to-day. But few countries there are that have a history so wrapt in mystery as Southern India. While the northern portion of the continent can trace back the stories of successive dynasties from Moghuls and Pathans right away to the Bactrian rulers of the far north-west, the south knows nothing of her former existence, save what can be gleaned from such meagre information as the grant of some village to a Brahman priest, or an inscription rudely traced on a temple wall can supply. Nor is the case different with the successive coinages of the two portions of the peninsula. While the issues of the north are for the most part characterized by fair execution and legible inscriptions, we usually find on the medals of the south but little that can aid us in their identification. All the more reason then for those interested in numismatology to turn their attention in this direction, in order that fresh light may be thrown on a subject now wrapt in too dark a mystery. It is only by united effort that any solid addition to our present scanty knowledge can be gained and the recollection that every day the smelting

pots of the goldsmith and coppersmith are claiming their victims, while the cabinet of our Central Museum is but rarely blessed with a fresh issue, should urge each flagging collector to fresh exertions.

It is not, however, intended in the present paper to go deeply into any type of Southern Indian coins, but rather in a short space to give a few hints to the tyro, who is just commencing this most fascinating study; to help him in the identification of the commoner issues he is likely to meet with in this part of the continent; and in the hope that this may be followed by other papers going more deeply into the coins of the various dynasties, which men of greater experience, such as Mr. Scott of Madura, or the Rev. James E. Tracy of Tirumangalam, could easily supply.

Many, doubtless, are deterred at the outset, by the difficulty of identification, which presents itself with their first "find." As I have already said, most of the issues of this part of the country boast no inscription to guide us; but for all that, there are not wanting distinguishing badges, which can in very many, if not in most, instances help us to assign them fairly approximately. It is, then, with a view to pointing out the most prominent of these to the tyro, and thus enlisting fresh recruits in the slowly-increasing ranks of coin-students in Southern India, that this paper appears. In Calcutta, the journal of the A.S.B., in almost every issue publishes fresh coins that have come to light, whereas here in Madras [1] nothing of the kind has been done, since Sir Walter Elliot's "Numismatic Gleanings" appeared in the pages of this journal for 1858. What little literature has been already published on the subject has either become so scarce as to command [2] a prohibitive price or, like Hawkes'

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[1] Sir Walter Elliot's contribution to the "Numismata Orientalia" had not been received when this paper was commenced.

[2] A copy of Princep's "Indian Antiquities" now fetches as much as £10 10*s*.

invaluable little pamphlet on the coins of Mysore, is out of print. Under the able supervision of the present Superintendent of the Central Museum, a great step in the right direction has been taken, by the arranging of all the copper issues of this part of the country; but many sections are still woefully weak in specimens, notably those of the Cholas, Pandyans, and Chalukyans. As the phalanx of collectors increases, let us hope however that duplicate specimens (and originals with non-collectors) may find their way into a collection which should be as nearly perfect as possible.

To the collector who has been at work any time, the enormous number of coins scattered throughout the country cannot fail to be a subject of wonder. The beginner, on the other hand, or the owner of a few specimens, who has never really *hunted*, will probably complain of the scarcity of issues procurable. The writer has purchased in one place, in two days, no less than 28 lb. weight of copper coins, and yet been told by residents on the spot that search is hopeless, and that no coins were ever found there. Let not the tyro then be discouraged at a few blank days. Every village in India contains coins—gold ones among the jewels of the rich, copper ones among the rubbish of the poor—but it takes tact, patience, and practice to lure them from their lurking places. It is no unusual thing to hunt through a village without seeing a sign of a coin, and be assured that there never were any, and yet the next day, armed with a handful of old coppers, as example of what one wants, to ferret out some prizes. To the native mind an *old* coin is of no more value than a modern one of identical weight and of infinitely less interest, and it is only when the mild Hindu realizes that for one pie that is old, he can get two pies that are current, that his little store is unearthed. Take, as I have said, a handful of old coppers with you, and sitting on his doorstep show them to the village shroff, and try to coax out whatever he may have. Encourage passers-by to stop and gape, and gradually

whatever the village contains will be at your mercy, and a prize thus gained is a prize indeed.

But however difficult the procuring old coins may be, the identification is doubly so at first, and yet with a little practice it is wonderful how soon one can pick out the choicest morsels from a chatty-full of rubbish. Gold coins down here are now so rare that (with the exception of an occasional interloper) one can pretty easily remember them all ; while silver pieces, prior to the issues of the East India Company, and excepting an occasional "punch-marked" Buddhist, may be said to be practically non-existent. Of copper, thousands of thousands are found, and it is to these that we must turn our attention chiefly. And perhaps a word or two here about the sizes and weights of these coins may not be out of place. The Chola and Pandyan issues appear to have been struck in three sizes, the largest and smallest of which are found both in copper and gold, while the medium size has only been found in the former metal. The largest is just about the size of a four-anna piece, the medium slightly more than half this and the smallest, in copper, only just large enough to receive one letter of the inscription, though slightly larger in gold. The average weights are, approximately, in gold 68 and 7½ to 8 grains, and in copper 60, 24 and 9 grains, respectively.

Mahomedan issues (chiefly Pathan) which occur in considerable numbers—having wandered down south either in course of trade, in the scrips of pilgrims, or brought by the conquering hordes of the north—are in rupees and mohurs, each of approximately the same weight and averaging generally from 160 to 170 grains, while the copper issues, usually more or less alloyed with silver, vary very considerably. The Hindu pagoda and fanam are both of gold, the former, usually almost a spherical coin, and weighing about 52 grains, the latter a small thin piece rarely reaching 6 grains. The early French issues struck in Southern India are of two

sizes in copper and two in silver, their respective weights being approximately $57\frac{1}{2}$ and $32\frac{1}{2}$ grains in the former and 45 and $22\frac{1}{2}$ grains in the latter metal. As far back as 1668, issues of English silver money were struck in Bombay. In the latter part of the last and early part of the present century, English medals were coined following the Mahomedan and Hindu systems. Those current in the south consisted firstly of the single star and other pagodas in the Hindu style (weighing from 52 to $52\frac{1}{2}$ grains), and subsequently of a more modern type of coin in double [3] and single pagodas, weighing 91 and $45\frac{1}{2}$ grains, respectively, in gold, while the silver series of half and quarter pagodas weighed 325 and $162\frac{1}{2}$ grains and the silver fanam 29. By royal proclamation of the 7th January 1818, the pagoda series gave way, and the rupee of 180 grains (350 to 100 pagodas) became the current coin of the country, and has so continued ever since to the sorrow of many a father with a family in the old country.

To turn now to the coins that are most commonly met with in the southern districts of the peninsula, we find that the earliest represented are evidently of a Buddhist origin, and these are found from end to end of India, and are by no means uncommon in the Island of Ceylon. Through them we trace the early history of coining. First we have small pieces of metal, some rectangular, some circular and some apparently slices cut from a bar of metal. These we

No. 1.

find followed by irregular flat pieces of silver and copper, at first utterly devoid of any mark, but later bearing the impression of some device or devices *punched* upon them, and hence known as the "punch-marked" Buddhist type. Though by no means common, they are met with in silver, gold and copper, the first being by far the commonest. An examination of a few of these coins

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[3] Journal As. Soc., Beng., Vol. LII, Part I, No. 24.

will show that all the marks they bear were not stamped upon them at one time, as one device is often seen to override another; and hence we may conclude that successive kings (or periods) stamped on the coins in general use a mark of their own sovereignty or time. The earliest emblem of all would seem to be the sun, in the form of a rayed circle, for this device appears upon every issue more or less distinct and is followed by a number of others, such as the "chaitya," the "chakra" or wheel, the "caducens" or wizard's rod, the Buddhist tree, &c. Of these Sir Walter Elliot, in his recent contribution to the "Numismata Orientalia" has figured a considerable number of specimens, and many were also illustrated in the early numbers of this journal.[4] From them we pass to the more recent *die*-made issues, of which specimens in copper are frequently met with in Southern India, especially in that most prolific coin centre, Madura. These are almost invariably rectangular and bear on one side an elephant with apparently Buddhist symbols, and on the reverse a checquered pattern as shown in No. 2, beneath which is a wavy line. The native legend is that these coins were struck in Madura at a very early period, and that the line denotes the river, while the checquered pattern is supposed to represent a plan of the city.

No. 2.

It is not, however, only in the ordinary coin metals (gold, silver and copper) that the collector will find issues bearing evidently Buddhist emblems. He will not be long on the hunt before he comes across circular (and rarely rectangular) coins in *lead*. These are found, for the most part in the Krishna and Godavari districts, but occasionally in Mysore, and other parts of the south, and are usually attributed to the Andhras, a dynasty of considerable antiquity, mentioned by Pliny,[5] but whose story is wrapt in prehistoric mys-

[4] Madras Jour. Lit. and Science, Vol. IV, No. 7 (1858 J).

[5] Pliny, lib. V, cap. XVII, "Validior deinde gens Andaræ," &c.

tery. These coins, for the most part, bear on the obverse a horse, a lion, an elephant or some other animal, the reverse being occupied by what is usually known as the "four-balled chakra," a form of the Buddhist wheel.

No. 3.

Travelling down southward now along the eastern coast, we find, chiefly on or near the sea-shore, a type of coin, rare in silver but fairly common in copper, all with the metal beaten very thin and exceedingly brittle, bearing on the obverse almost invariably a bull, and on the reverse a rayed "chakra" or wheel, and occasionally a device not unlike a symbolical altar. These occur in considerable numbers near the Seven Pagodas (Mahavalipuram), and are usually attributed to the Curumbars, a race of some power, which lasted till about the eighth century of our era, when they fell before the Cholas who annexed their country. The Rev. W. Taylor, in his account of the Mackenzie MSS., observes of this people, that "they had a certain kind of religion; they were murderers; they derived their name of Curumbars from their cruelty. Some of them spread into Dravida desám as far as the Tonda-Mundala country. They are now found near Uttramalur,[6] but are more civilized. They ruled the country some time, but falling into strife among themselves, they at length agreed to select a chief, who should unite them together. They chose a man who had some knowledge of books; who was chief of the Dravida country, and was called Camanda Curumbar Prabhu, and Pallal Rajah. He built a fort in Puralur. He divided the Curumbar land into twenty-four parts, and constructed a fort in each district, ... While without any religion, a Jaina (Buddhist) ascetic came and turned them to the Jaina credence. ..... At length Adondai of Tanjore formed the design of sub-

Nos. 4, 5, 6.

[6] A village, according to Sewell, some 15 miles from Madrantikam.

duing them, and invading them, a fierce battle was fought in front of the Pural fort, in which the Curumbar king's troops fought and fell with bravery; and two-thirds of Adondai's army was cut up. He retreated to a distance overwhelmed with grief ; and the place where he halted is still called Cholan-pedu. While thinking of returning to Tanjore, Siva that night appeared to him in a dream, and promised him victory over the Curumbars, guaranteed by a sign. The sign occurred ; and the Curumba troops were the same day routed with great slaughter ; the king was taken, the Pural fort was thrown down, and its brazen (or bell-metal) gate was fixed in front of the shrine at Tanjore." Sewell (in his account of the dynasties of Southern India) considers some of the figures carved round the base of a pillar in the Kachalésvarasvámi temple to be portraits of Curumbars, and describes them as there represented as being " woodsmen with peculiar high caps, short swords (?) and water-gourds slung over their shoulders. The features, " he adds, " are highly characteristic and are utterly unlike those of any other sculptured figures I have seen in Southern India." The occurrence on their coins, as also occasionally on those of the Andhras, of a " d'honi " or native boat, seems to prove that they were a maritime people carrying on a commerce by sea.

We must now pass to a short consideration of the marks which distinguished the coins of the three large dynasties which at one time held sway in Southern India generally, viz., the Cholas, Pandyans, and Cheras. Tradition has it that in prehistoric times the whole of this part of the country was ruled by three brothers of the names of Cholan, Pandayan, and Cheran, and from these sprang the three powerful dynasties which took their names. The power of the Cheras never seems to have been very great, though their nominal sovereignty extended from the country round their capital, Salem, away to the hills of Travancore and

Palnai. The Pandyans had their capital at Madura, and included in their boundaries the most southern portion of the peninsula (with the exception generally of the country round Ramnad, which was under the dominion of the Setupatis); while the Cholas, with their capital usually at Tanjore, ruled the surrounding districts, amusing themselves constantly with inroads into their neighbours' territories, sometimes even as far as Ceylon. Each of these three powers bore on its flag a distinctive emblem or badge. The Cheras boasted a bow, the Pandyans a fish, and the Cholas a tiger, though the coins of the latter are usually distinguishable by the rude figure of a "rakshasa" or man standing upright, with head thrown back, and apparently holding in front of his

No. 7.

face a flower. In his pendant right arm he holds a weapon (?). A straight line between his legs, and a waving one on either side, mark his flowing "daputa" or cloth, and under his left arm usually appear five dots. The reverse bears a similar figure curled up in an uncomfortable position, with legs crossed, his right hand resting on his right leg. Beneath the left arm we usually find the name of the king, or rarely some emblem, such as the Pandyan fish. No collector will be on the hunt long, especially in or round that rich treasure-house of coins, Madura, without meeting with large numbers of specimens of the issues of Raja Raja, the greatest of the Chola princes, who ruled in the eleventh century, when the power of his race was at its zenith, and no better type of Chola issues than his could be found. So plentiful are they,

No. 7.

indeed, that one cannot help being led to the conclusion that all those one meets with bearing his name could more probably be attributed to a line of kings than all be issues of a single sovereign.

The constant warfare which raged between Chola and Pandyan not only renders it well nigh impossible at any

particular time to fix the exact boundaries of their respective territories, but also causes considerable uncertainty in the identity of a large number of their coins. When the Pandyans conquered, they appear to have retained their fish, adding thereto the Chola emblem; and when the Cholas were victorious, they returned the compliment—a custom which extended down even to the times of the Mahomedan power in Mysore, where we find Hyder, that most bigoted of Musalmans, retaining a Hindu reverse to his fanams and pagodas, while his own initial adorned the obverse. Thus in No. 8 we have a coin [7] which bears the name of Raja Raja with the usual Chola emblem, but instead of the five dots common to most coins of the type, we here find the Pandyan fish. Then again in No. 18 we have a coin which, while it bears the name of Sundara Pandya ("Pandya the Beautiful," possibly a title of the Pandyan monarchs generally and not the name of any particular king), has on the obverse the standing figure of the Cholas. In No. 10 again we find a boar, the emblem of the Chalukyan dynasty, in combination with the two fish and sceptre of the Pandyans.[8] While then we can with comparative safety lay down the axiom that where the fish occurs, the Pandyan has something to do with it, and that the tiger or standing figure proves that when the coin was struck the Chola had a finger in the pie, in the absence of any distinct legend it is impossible to place each issue exactly. To enter at all deeply into the numerous combinations that are constantly being brought to light would carry me far beyond the limits of this paper; but I cannot help here again expressing the hope that ere

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[7] It is only within the last few weeks that this coin has been brought to light, and, as far as I can ascertain, only two specimens of it have as yet been found.

[8] *Apropos* of this coin it may be interesting to note that Rajendra Chola, who subdued the Pandyans, is supposed by some to be a descendant of the Chalukyans.

long some record of the researches of those who have made a study of those coins their *specialité* may appear in these pages. There is, however, one branch of the Chola issues to which I must briefly allude. The tyro will probably find among his coins ere long a type which, while resembling generally the common issues of Raja Raja, yet differs from them in a marked degree. The coins I allude to are more perfectly round, the figures stand out in bolder relief, the letters are in a squarer type of Nagari, and whereas the edges of the Indian type are worn thin, these are usually as square as a modern shilling. These coins, known as the Simhalese (Cingalese) type of Cholas, were struck by the kings of Ceylon, the Indian Chola coin being in all probability the prototype. The incursions of the Cholas would naturally lead to the introduction of their coins, and it is more than probable that this led to the coinage of the series in the island. Two

Nos. 11 and 12.

specimens of these I figure,[9] the former appearing only in copper and being fairly common, while the latter, known as the "Lankesvara" coin, is of gold and by no means rare. Both are issues of Parakrama the great (A.D. 1153), and their constant occurrence in Southern India goes to prove the intimate connection that must have existed between the island and mainland, though this does not always appear to have been of a friendly nature. Later Indian issues, while retaining the original obverse, have on the reverse sometimes an elephant and sometimes a bull (as in No. 13), but as none of these bear any name or title it is impossible to say whether they should be attributed to rulers of the island or the continent.

The Pandyan emblem, as I have said, was the fish, and this appears sometimes singly in the centre of the coin with a sun and moon in the field, while in others two fish are

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[9] A very full description of this series will be found in Rhys Davis' article in Vol. I of the "Numismata Orientalia," Part VI.

represented with either a sceptre or inscription between.

No. 14.

Sometimes the fish appear crossed, and in later issues it occupies the exergum, with a dancing figure of Vishnu or Garuda in the field. Unlike

No. 15.

the coins of the Ċholas, the Pandyan issues usually bear an inscription, but unfortunately out of thousands of specimens that are constantly being found at and near the old Pandyan capital, it is but very rarely that one meets with a single medal with an inscription of which more than one or two letters are decipherable. Nor have we, to help us here, what countries with a written history can boast, a reliable list of the sovereigns of the various dynasties that have ruled. In Pandyan issues especially, owing to the bad state of preservation in which they are usually found, the want of some such list is more than ever felt. By far the commonest name decipherable on their coins is Sundara Pandya, and it is not improbable from the variations in the coins bearing this name, that it was merely a dynastic title. Other names certainly occur, such, for example, as appear to read "Korkai Andán, Kula Shek'hara, Vira Pandya, Soku Laban, Bhutála, Samara Kolahala (No. 15), &c.," and though among these here and there appear one or two names, such as Kula Shek'hara, Vira Pandya and Samara Kolahala, which have found a place in one or two of the numerous lists that have been published from time to time, founded on grants and inscriptions of the period, by far the greater number bear "names—empty names," the very reading of which is in many instances decidedly doubtful. Other coins again, instead of recording the name of the king who struck them, merely record an event in his reign. Such is the case with No. 14, on the reverse of which appear the words "Kanchi

No. 14.

Valankun Perumal" (the king who gave back Kanchi or Conjeeveram) and this may connect the piece with Sundara Pandya of Nelson's list,

for in an inscription cut in a rock "which forms the side of an old ruined Saiva church near Tirupparankunram," and which is translated in the "Madura Manual," we find as one of the recommendations of Sundara Pandya—

"Who, when the Chola, who had fled after being deprived of his kingdom and city, returned in confidence and presented to him his (the Chola's) son, declaring (complimentarily) that his son bore the title of Pandya, and prostrated himself before the Pandya's victorious throne, and humbly besought him; who then went and took hold of his hands, putting aside all anger, and pouring water on them presented the conquered territory to the son of the Chola. Then the kings of all the countries of the world, surrounded by the ocean that has great waves, paid their respects to the Pandya, the benefactor of all, and begged of him that this kingdom presented by him of his freewill to the son of the Chola, to whom had been joyfully (or out of compliment) given the Pandya's name, should thenceforward be known as 'the kingdom once conquered by the Pandya.' Who then presented him with the Chola kingdom and with the Srî Muk'ha or order to use as his signature a seal, representing a bright fish; entitling him 'the king of the country which was before lost;' and giving him also the old capital[10] city, and then gave him leave to depart."

This passage, when we remember that Kanchi (Conjeeveram) was at one time the Chola capital, would certainly appear to connect the coin with the king here referred to, who, having done a generous thing, was by no means inclined to hide his light under a bushel.[11]

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[10] In the Madura "St'hala Purana" (12th story) the same event is noticed, the conquered king being there called "The Chola king of Kanchipura."

[11] Thus also among the early Bactrians, we find a king of such inordinate vanity that because he was known in his own time as "the Great Saviour" (Σωτηρ μεγας) considered it unnecessary to put his own name on his coins. To this day his issues are among the commonest one meets with in the whole series, but his name remains a mystery still.

Another coin, bearing the same name, I also figure as being very unlike the usual type of Pandyan issues. Whether the figure is standing, or sitting on a two-legged stool in the attitude of a Jain figure, I am unable to say, but incline to the former opinion, though the latter may be possible, as, though usually Sivaites, there appears to have been at one time a tendency to Jain worship among the early Pandyans. And this leads me to speak of another type of coin which occurs in large numbers in and round Madura. These invariably bear the "lingam" on one side, sometimes plain sometimes surrounded by a row of dots, which may possibly be intended to represent a wreath of flowers, and sometimes in a "vimana" or shrine while the reverse has two standing figures. At other times again it appears perched on the back of a bull and occasionally on a bird, possibly in connection with Minakshi, Siva's wife, who was held in great reverence in Madura. In the absence of any legend, it is of course impossible to fix such coins with any degree of certainty; but the fact of their being found in considerable numbers, and often in conjunction with Pandyan issues, at the old Pandyan head-quarters, and the certainty that this people were ardent worshippers of Siva in this form, would seem to me fair circumstantial evidence on which to base this theory.

No. 9.

No. 16.

No. 17.

About the middle of the sixteenth century the Pandyan dynasty gave place to the Nayakas. Having quarrelled among themselves and fallen a prey to the Cholas who invaded their country,[12] the Pandyan king sought assistance from the Raja of Vijayanagar, who sent an army first under a general of the name of Kotiya Nágama, and then to keep them in order a second under Nágama's son Visvanatha.

[12] See Sewell's Archæological Survey of Southern India, Vol. II, p. 200.

He, being a man of parts, duly conquered his enemies nominally reinstated the rightful king, but put himself in to act, and then, *more antiquorum*, confirmed himself and became sole ruler. He on his coinage followed the custom of the country and retained the two[13] fish and sceptre of the Pandyan, inscribing his own name around it. But few coins of the Nayaks seem to be found, but those that do occur usually have on the obverse a figure of Garuda or Hanuman with inscriptions (almost invariably too worn to be legible) on the reverse. As far as I can learn, no gold coin of the Nayaka dynasty has yet been discovered.

The Cheras, as I said above, supplies the coin-collector with but very few specimens. Two types only occur which may with some degree of reason be attributed to them.

No. 32.

The first of these shows on one side the "katar" or native long-handled dagger, and on the other the bow—the coins being thin and in appearance not unlike those of the Curumbars, of which I have already spoken. The other type belongs evidently to a later period, and is a round dumpy piece, having on the reveise a design regarding the identity of

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[13] Sir Walter Elliot, in his recent contribution to the "Numismata Orientalia," figures a coin as No. 144 bearing these same emblems, and an exactly similar one in my own collection, found at Madura, is very distinct. Regarding this and the coin which follows it in his sequence, he says: "This is a coin with the Ceylon type on both sides with the addition on the obverse of two fish and a crozier, and on the reverse, under the arm, letters which appear to read '*Terumalai*' and may refer to a Nayak of Madura. . . . . Another coin has the recumbent bull and the word '*Ketu*' and the standing figure on the obverse, but as there is no fish it is doubtful whether a Pandyan reign can be assigned to it." Now regarding the first of these two coins, this issue bears the undoubted name of the first Nayaka Visvanatha; hence, as this one hails from the same place, bears the same marks, and so nearly the name of one of the greatest kings of the same dynasty, we may with a fair show of reason assign it to the great Tirumala, the builder of the famous palace at Madura. The reading on the latter coin is "*Setu*" and not "*Ketu*" in two specimens that I have, the first letter being plainly செ, and the piece I attribute to the Setupathis, or rulers of Ramnad. I came across some of the same type, and in two sizes, in Ceylon.

which I have never heard any theory suggested and am unable to form any opinion, while on the obverse appear numerous symbols, but invariably the bow, the Chera emblem, on either the right or left. These coins are met with chiefly in Tripati, Salem and the Coimbatore district.

Nos. 19, 20.

Early in the fourteenth century arose the Vijayanagar dynasty, which eventually grew to be the most powerful that Southern India has ever known. Its capital was at Beejnagar (or Humpi) some thirty miles to the north of Bellary, and its power when at its zenith extended over the greater part of the south, but at the battle of Talikota (A.D. 1565), they fell to rise no more before the Mahomedan armies of the Dakhan, the raja and his descendants retiring to the hill forts of Pennakonda,[14] in the Anantapur district, Vellore and Chandragiri. From the latter fortress "Sri [15] Rang Raya, the then representative of the old house, granted in 1640 a deed handing over to the English the site of modern Madras. Unfortunately that document was lost during the French occupation of Fort St. George, but it is stated that in addition to the grant of land, it conferred the privilege of coining money, on the condition that the English should preserve on their coinage the 'representation [16] of that deity who was the favorite object of his worship.'"

How these conditions were actually fulfilled we shall see when considering the early English issues of Southern India. A tentative list of the successive monarchs of the Vijayanagar line has been published by Mr. Sewell in the second volume of his Archæological Survey Report of Southern India, and among them occur several names familiar to the coin-collector in this part. Like their predecessors they had

[14] Sewell's Archæological Survey, Vol. I, p. 119.

[15] Bidie's "The Pagoda or Varáha Coins of Southern India."

[16] Marsden's "Numismata Orientalia," Part II, p. 739.

no silver currency, but their gold pagodas are frequently met with still in every part of their once wide dominions. These pieces, usually averaging about 52 grains in weight, have been pretty exhaustively treated of by Surgeon-General Bidie in his valuable contribution [17] to the Asiatic Society of Bengal, a paper that has since been published in pamphlet form by Messrs. Higginbotham and Co. of Madras, and which should find a place in the library of every coin-collector in the presidency. Of silver coins they had none, but copper issues attributable to them are found over the length and breadth of Southern India. On one side these bear the figure of some deity of the Hindu mythology, while the reverses vary very considerably. The coins of Deva Raya bear usually with his name the figure of a bull or elephant, or the *Ganḍa Bheruṇḍa* or double-headed bird so familiar to us on palamposhes and tapestries. Tirumala has on the obverses of his pieces Hanuman (the monkey god). Krishna Deva takes Garuda, the winged vehicle of Vishnu. Sadasiva used Durgi, the boar incarnation of the same deity. A long series of apparently a later date bear on one side the word "Sridhara" in Telugu, and on the other a variety of symbols such as the sun, the sun and moon, an elephant, a lion, one or two snakes, a gecho, Narasimha (the lion-faced form of Vishnu), Hanuman (the monkey god), Ganesa in the form of an elephant, or two gods sitting side by side. There are two coins very similar to these to which I must here allude, as I have seen them in more than one collection attributed to this series.

Nos. 21 and 22.

No. 23.

The first of them, one-twentieth of an anna in value, bears on one side the word విజయ, either meaning "victory" or more probably the initial letters of విజయరఘునాధతొణ్బ్బయాన్సాహేబ్ (A.D. 1729—67) in whose reign the first issue was coined. The coin belongs

[17] Journal As. Soc., Bengal, Vol. LI, Part I, 1883.

to the State of Puducottah, and regarding it Mr. Seshiah Sastri, C.S.I., the present enlightened Dewan of the Tondiman Rajah, in a recent letter, informs me—

"On the reverse is the figure of Brahadamba అంబా the family deity of the Tondiman. This figure gives the name to the coin, which is current only within this State" (Puducotta). "It is coined locally in a rough way, and its greatest circulation is during 'Navarathri' or 'Dusserah,' when it is issued (4 to each) along with the rice dole every day during the nine days. It seems that in Madura a similar coin was in circulation with a similar figure, but in a standing posture" (this I figure as No. 24). "Here the sitting posture was adopted to distinguish it from the other, which up to that time used to circulate in this State also."

On the break up of the Vijayanagar power on the battle-field of Talikota, a thousand and one petty chieftains, who had sworn eternal fealty to them in the days of their greatness, declared themselves independent and started mints on their own account, but the coins they struck are characterised in most instances by being as puny in comparison with those of Vijayanagar as was their power with that of their former rulers. Some of them appear merely to have copied the issues of their predecessors while others coined minute gold pieces known as "fanams," a term which later came to be used as an item in the English monetary system in South India. All of those that I have come across have been figured by me in a recent issue of the Journal of the Asiatic Society[18] and I therefore pass them by unnoticed here,[19] merely picturing one as an example of the series. This small piece of money was coined by Kanthirava Ars, who from 1638 to 1658 A. D. ruled the province of Mysore, and whose

No. 25.

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[18] Journal As. Soc., Bengal, Vol. LV, Part. I, 1886.

[19] Since writing this I have been lucky enough to meet with a hitherto unpublished coin of this size struck by a Chola king, notice of which I reserve for a future number of this journal.

successors seem to have made re-issues thereof, so that the coin is fairly common among the *Olla Podrida* usually to be found in the bags of the shroffs of the Mysore towns. Early copper coins of the province (?) are also occasionally met with bearing on one side a well defined figure of a dragon or other animal or Kanarese numeral and on the reverse a checquered pattern. From the fact that I have met with some dozen specimens of this coin in or near Mysore and Seringapatam, and (with the exception of two I procured in Bangalore) have never found them elsewhere, I attribute them to this province, with which the dragon and character of the numerals also connect them. The same reverse also appears on what are known in Mysore as the "âne paisa" or elephant pice, having a figure of an elephant with the sun, moon, or both, above, and which are exceedingly common there.

Towards the middle of the 18th century, we find Mahomedan interests gaining the ascendancy in the Mysore province, and with it, as might be expected, a finer type of money than any that had preceded it, coming into vogue. In 1766 Nanjeraj succeeded to the sovereignty of the State, and during his reign the famous Hyder rose to power.

In 1775 the king died, and his successor being a child, the reins of government fell into the hands of the unscrupulous Musalman, with whose usurpation the well-marked, neatly executed coins, which had for years characterized the Mahomedan mints of the north, came into vogue, their clear cut impressions and legible superscriptions forming indeed a striking contrast to the usually rough issues of the Hindu monarchs of the south. In his coins the reverse bore (ح) his initial in substitution of the word "Sri" which had previously marked them, while on the obverse he retained the old pagoda form, Siva and Parvati sitting side by side and holding the deer and trisul. He established several mints, such as Bangalore, Bednoor and Calicut, which

latter place he conquered in A.D. 1773. Unlike the coins of the Hindus, too, those struck by Mahomedans almost invariably bear a date, and as many such issues are met with, regarding which I shall have to speak hereafter, a word or two on the subject of their dates may not be unwelcome to the uninitiated.

Unlike ordinary Persian or Hindustani writing, numbers in that language are read from left to right, the numerals being represented as follows :—

٠	١	٢	٣	۴	۵	۶	٧	٨	٩	١٠
0	1	2	3	4	5	6	7	8	9	10

Their years reckon from the Hijrah or exodus of Mahomed, which took place on the 16th July 622 A. D., and as the reduction of the Hijrah dates to those of our era is often necessary for the identification of many coins one meets with, especially those in which the year is legible, while the name of the ruling sovereign is effaced, I append the Hijrah dates corresponding to the commencement of each half century of our era.

A.H.	A.D.	A.H.	A.D.
1	622-[20]7	700	1300- 9
50	670- 1	750	1349- 3
100	718- 8	800	1397- 9
150	767- 2	850	1446- 3
200	815- 8	900	1494-10
250	864- 2	950	1543- 4
300	912- 8	1000	1591-10
350	961- 2	1050	1640- 4
400	1009- 8	1100	1688-10
450	1058- 2	1150	1737- 5
500	1106- 9	1200	1785-11
550	1155- 3	1250	1834- 5
600	1203- 9	1300	1882-11
650	1252- 3		

[20] That is, commencing in the 7th month (July) of that year.

There is, however, one notable instance in which these do not hold good. On the accession of Tipu to his father's throne in Mysore, he greatly enlarged the number and variety of coins in circulation in his dominions; and, being a man withal of an inventive turn of mind, started an era of his own, which counted not from the *flight* but from the *conversion* of Mahomed twelve years before the Hijrah. Hence it is no unusual thing to find coins of Tipu's to all appearance posthumous. This system he was pleased to christen [21] Múlúdie and in it the numbers read *from right to left*. A specimen of this I figure as No. 26, on the reverse of which appears "Sun Múlúdie 1226 (سن مولودی ٦٢٢١) corresponding to 1811 of our reckoning, whereas Tipu completed the sum of his iniquities in A.D. 1799.

During his reign, [22] two distinct systems of coins were in use in Mysore—the mohurs and rupees of the Mahomedans side by side with the pagodas and fanams of the Hindu. The former of these included double, single and half gold mohurs (though as far as I can learn there is no specimen of the first extant) and double, single and half rupees. The whole series (known as the "Sultani") resembles very closely the double rupee I figure as No. 27, though the inscriptions on all vary slightly in minor details. The usual inscription is as follows:—

No. 27.

"دين احمد در جهان روشن است فتح حيدر ضرب پتن سال هجری سن ١٢٠٠"

by Hyder's victories is the faith of Ahmad made bright in

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[21] Mir Hussein Ali Khan Kirmani, in his history of the reign of Tipu (a continuation of the "Neshani Hyduri"), says: "The institution of the Muhammadi year, which is thirteen years more than, or exceeding that of, the Hijri, it being reckoned from the conclusion of the prophet's office and the commencement of the duties of his mission (the office of prophet and that of a particular mission are considered distinct), being previously arranged and ready, was now made current throughout the whole extent of the Sultan's dominions."

[22] Hence, in Article II of the "Treaty of peace between the confederated powers and Tipu Sultan," we read, "Three kroor and thirty lak of rupihs to be paid by Tippoo Sultan in gold mohurs, pagodas, or bullion."

the world. Struck at Pattan (Seringapatam) in the year of the Hijrah 1200." The smaller coins corresponding to this series are known as the "Bakri," struck in the sixth year of his reign (and so called possibly after Mahomed Báker, the Fourth Khalif) the "Jasri" or two anna piece struck in the eleventh year, the one anna bearing the word "Kazmi" struck in the twelfth and a ½ anna, also in silver, with the word "Kizri" impressed thereon. In all these coins the milling is different to that of any other coins I know; the lines instead of running straight across, as usually in milled coins, are angular, the angles pointing along the circumference, a feature which renders the detections of many forgeries at once apparent.

(The pagodas and fanams struck by him and the states dependent on Mysore have been so recently and so fully treated on in the two papers to which I have alluded above that they require no notice here.)

During Tipu's reign a very large number of copper coins were in circulation, and these are still common in every bazaar in the province. As a rule they bear the elephant on the obverse and on the reverse the mint town. Above the elephant in some instances he places the date, sometimes reckoned by the Hijrah era, at others following his own patent system. Others again he inscribed with the name of a planet, usually that of Jupiter (Mushta) over the larger and of Venus (Z'hera) over the smaller, while others bear only the word "akhtur" (star). Another series, again, are distinguished by the addition over the elephant of one of the three first letters of the Persian alphabet. Hawkes, in his invaluable little pamphlet on the coins of Mysore (published in 1857), entered most exhaustively into the copper issues of Tipu, but unfortunately his useful little book is now out of print and no longer procurable, though an exhaustive catalogue of the coins in the Madras Central Museum, now in the press, will go far to supply its place.

On the fall of Tipu and the return to power of the Hindu line, the elephant was at first continued, but the Persian inscription gave place to Kanarese and a rude style of English in which it is not unusual to find one or more letters upside down. Shortly afterwards the Mysore lion was substituted for the elephant, and this device continued to be in vogue till the province ceased to have a distinctive coinage of its own. In gold the Hindu raj still held to the old Ikkeri type of pagoda, which with a different reverse had been continued through the Musalman period, the words "Sri Maharaja Krishna" now taking the place of Hyder's initial. He also made a re-issue of the canteroy fanam and a series in silver of (approximately) four, two, and one anna pieces, bearing on one side the dancing figure of Chamundi and on the other an inscription in Hindustani on the larger, and in Kanarese on the two smaller issues. All these are very plentiful still in Mysore.

No. 28.

No. 29.

No. 31.

Having thus rapidly glanced at the various coinages of the different dynasties which have been indigenous to Southern India, and endeavoured to point out some of the symbols, which alone in so many instances can guide us in the identification of these coins, and in the hope that such may prove of some assistance to the tyro, who is just beginning this most fascinating pursuit, I reserve for a future paper the consideration of those coins which, though still plentiful in Southern India, were struck by powers foreign to this country, such as the Romans, Pathans, Moghuls, Dutch, French, English, Portuguese, &c., all of which occur with more or less frequency and are apt to confuse the tyro considerably.

A Pallava Inscription from Amaravati.

(By E. HULTZSCH, Ph.D.)

The subjoined Sanskrit inscription is engraved on three sides of an octagonal pillar,[1] which was excavated at Amarâvatî by Mr. Sewell and is now put up in the Madras Museum. The top of the pillar and some letters of the uppermost lines of the inscription have been broken off. The inscription has hitherto remained a puzzle, as each line seems to end incomplete. Finding that the first words of some lines were connected with the last words of the following lines, I was led to suppose that the inscription must begin from the bottom and not from the top. Curiously enough, this is really the case. If the inscription is read upwards, we find that it consists of eleven complete verses and of a prose passage, the end of which is lost through the mutilation of the pillar at the top.

The inscription opens with an invocation of *Buddha* and with a mythical genealogy of *Pallava*, the supposed founder of the Pallava dynasty.

Brahman.
|
Bharadvâja.
|
Aṅgiras.
|
Sudhâman.
|
Droṇa.
|

[1] See Dr. Burgess' *Notes on the Amarâvatî Stûpa*, p. 49*f.*

Aśvatthâman, married to the apsaras Madanî.
|
Pallava.

Verse 8 gives a popular etymology of the name Pallava. Then there follow the names of seven Pallava kings :—

1. Mahendravarman, son of Pallava.
2. Siṁhavarman I, son of 1.
3. Arkavarman, son of 2.
4. Ugravarman.
6. Nandivarman, son of 5, Śrîsiṁhavishṇu.
7. Siṁhavarman II.

The inscription contains no information about the relationship which existed between 3 and 4, 4 and 5, 6 and 7. Neither does the genealogy agree with the lists derived by Mr. Foulkes [2] and Mr. Fleet [3] from other Pallava inscriptions, although similar names of kings occur in them. For these reasons great care should be taken in using the above list for historical purposes.

From the incomplete prose passage at the end of the inscription we learn that, on his return from an expedition to the north, *Siṁhavarman* II came to a place sacred to *Buddha*, which was called *Dhânyaghaṭa* (line 38) or *Dhânyaghaṭaka* (line 47). The lost part of the pillar must have recorded a donation which the king made to Buddha.

Dhânyaghaṭa or *Dhânyaghaṭaka* is evidently identical with *Dhânyakaṭa* or *Dhânyakaṭaka*, "corn-town," the well-known old name of Amarâvatî. The use of *gha* instead of *ka* [4] can perhaps be explained by the Tamil habit of pronouncing any guttural between two vowels like the North-German g in "wagen."

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[2] *Ind. Ant.*, Vol. VIII, p. 167, 273. *Salem Manual*, Vol. II, p. 349.

[3] *Kanarese Dynasties*, p. 16.

[4] Compare *pridhivi* for *prithivî*, *ubhâya* for *upâya*, and *parâbhara* for *parâpara*, in the Pallava inscriptions of Dharmarâja's Ratha at Seven Pagodas.

Text.

1 श्रियं वरां वश्चिरमादिशंतु ते भवद्विष[ः] श्री-
2 घनपादपांसवः [।] सुरासुराधीशशिखामणि-
3 त्विषामनांतरय्ये[5] विलसन्ति संचये ॥ [१] बभूव धा-
4 तुः प्रथमादकल्मषो मुनिर्ब्भरद्वाज इति श्रु-
5 तीश्वरः [।] ततोंगिरा नाम गिरापगोदधिस्तत-
6 स्सुधामेति मुनिर्व्विनिश्रुतः ॥ [२] ततस्समस्ता-
7 गमपारदृश्वा द्रोणाभिधानो मुनिरुग्रवीर्य्य[ः ।]
8 अतर्प्पयन्सोष्टतनुं[6] तपोभिर्व्वंशस्य कर्त्तुस्त-
9 नयस्य हेतोः ॥ [३] प्रसादेन ततश्शंभोरश्वात्था-[7]
10 मेति विश्रुतः [।] प्रादुर्ब्बभूव तेजस्वी प्रातर्ब्भा-
11 नुरिवोदयात् ॥ [४] तपस्यतस्तस्य किलाप्सरोद्धता
12 सुरेंद्रकन्या मदनीति विश्रुता [।] कदाचिदारण्यनि-[8]
13 वासिमन्दिरं दिदृक्षुरालोकपथं जगाम सा ॥ [५]
14 सरःप्रवातांबुजविस्खलप्रियावियोगभीतं[9]
15 कलहंसमण्डलं । अशोकभूमावुपविश्य
16 सस्पृहं विलोकयन्तीमुपतस्थिवानृषिं[10] ॥ [६] उमे-
17 व शर्व्वं प्रबभूव नात्मनो निरीक्षितं[11] काममिव-
18 र्षिवेषिनं[12] । अथोभयं गाढनिबद्धभावकं
19 सुरांगनास्संगमयांबभूविरे ॥ [७] असूत काले सुर-

---

5 Read *anantaraṁ ye.*
6 Read *atarpayat soshṭatanuṁ.*
7 Read *Aśvatthâ* °.
8 The wrong form *âraṇya*, instead of *araṇya*, is caused by the metre.
9 Read ° *viskhalatpriyâ* °.
10 Read *ṛishiḥ.*
11 Read *nirîkshya taṁ.*
12 Read ° *veshiṇam.*

20 राजकन्या नाथं भुवस्सागरमेखलायां[13] [।] सपल्लवो-[14]
21 घास्तरणे शयानं पिता सुतं पल्लव इत्यवादीः[15] [॥८]
22 महेंद्रवर्म्मेति ततः क्षितीशः शूरस्ततो जायति
23 सिंहवर्म्मा ॥ ततोर्क्कवर्म्मा तदनुग्रवर्म्मा[16] श्री-
24 सिंहविष्णोरथ नन्दिवर्म्मा ॥ [९] अनेकराजन्यशिरो-
25 मणिप्रभाविभातकल्पायितशार्व्वरास्थितिः [।]
26 स सिंहवर्म्मा समभूद्य उच्यते हयद्विपाष्टादशलक्षको
27 जनैः ॥ [१०] स सागरांबरामुर्व्वीं गंगामोक्तिकहारिणीं[17] [।] बभा-
28 र सुचिरं वीरो मेरुमन्दरकुण्डलां ॥ [११] अथ कदाचिदम-
29 रगिरिशिखरायमानकरिचरणनखरविदारितक-[18]
30 नकदलचरतुरगखुरमुखसमुत्थितवजस्ता-[19]
31 पनीयवितानितनभस्थलः[20] सकलमण्डलीकसाम-
32 न्तसमरवीरोपरचितपार्ष्णिपार्श्वपुरोनुरक्षोखि-
33 लदिग्विजयार्ज्जितयशाः स्थापनाय[21] सुमेरुशि-
34 खरमुपातिष्ठत ॥ तत्र किल निखिलधरणीतलप-
35 र्य्यटनजनितश्रममपनिनीषुः कतिपयानि
36 दिनानि नीत्वा कनकतटरुहहरिचन्दनतरुच्छायानन्दि-
37 तहृदयः ततो भागीरथीमुत्तीर्य्य तथैव गोदावरीं कृ-
38 ष्णवेर्ण्णं[22] च श्रीधान्यघटनगरन्नाम वीतरागभट्टारकम-
39 द्राक्षीत् [।] दृष्ट्वा सकुतूहलमखिलक्षेत्ररक्षणनि-
40 [यु]क्ताधिदेवतास्सविनयमुपगम्याभिवन्द्यैकान्ते

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13 Read ° *mekhalâyâḥ*.
14 Read *sapallavau* °.
15 Read *avâdît*.
16 Read *tadanûgravarmâ*.
17 Read ° *mauktika* °.
18 Read ° *śikharâyamâṇa* °.
19 Read ° *rajastâ* °.
20 Read ° *nabhastalaḥ*.
21 Read ° *yaśaḥsthâpanâya*.
22 Read ° *verṇâṁ*.

41 * * धर्म्मदेशानामशृणोत्[23] [।] श्रुत्वा चापरजन्मानं

42 * * [भि]वन्द्येदमुवाच [।] अहमपि भगवन् भगवतो

43 * * [दि]कामिहैव मणिकनकरजतविचित्रं कल्प-

44 * * * [ए]वमुक्ते भगवानुवाच । साधु साधु[24] उपा-

45 [सक सिंह]वर्म्मन् इतोपरमबुद्धक्षे[त्रश्री]-

46 * * * * * * * ष्वेवेति [।] ततो[भि]वन्द्य * * * *

47 * * * * * * * [धान्य]घटके * * * * * * * *

Translation.

(Verse 1.) May the dust of the glorious[25] feet of *Bhavadvish*,[26] which thickly covers[27] the multitude of brilliant crest-jewels of the lords of gods and of demons, for a long time show you (the way to) supreme glory!

(V. 2.) From the first creator (*Brahman*) there sprang a pure sage called *Bharadvâja*, who mastered the *śrutis*; from him an ocean (uniting) the rivers of speech, *Aṅgiras* by name; from him the renowned sage *Sudhâman*;

(V. 3.) From him a sage called *Droṇa*, who thoroughly knew all *âgamas* and who possessed terrible might. In order to obtain a son who would found a race, he strove to please the eight-formed (*Śiva*) by austerities.

(V. 4.) By the favour of *Śambhu* there arose to him a brilliant (son), famed by the name of *Aśvatthâman*, just as at morn the brilliant sun rises over the eastern mountain.

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23 Read ° *deśanâm.*

24 The letter *e* is written over *dhu.*

25 With *śrîghana* compare Pâli *sirîghaṇa* or *sirîghana* in the *Dîpavaṁsa*, I, 11; II, 1.

26 Literally, "the enemy of worldly existence." The prose passage at the end of the present inscription shows that *Buddha* is meant.

27 Litorally, "which glitters (or plays) without interstice on," etc.

(V. 5.) Once, surrounded by (other) celestial maidens, the famous nymph *Madanî*, who wished to see the abode of the hermits, entered the path of sight of that ascetic.

(V. 6.) The saint approached her, while, seated amongst a group of *aśoka*-trees, she was wistfully regarding the male swans, which were afraid of being separated from their beloved ones, whenever they lost sight of them behind a lotus of the lake, which was agitated by the wind.

(V. 7.) Perceiving him who resembled Cupid in the dress of a saint, she lost her self-control, just as *Umâ* on seeing *Śarva*. Then the nymphs united the couple which had conceived a deep affection (towards each other).

(V. 8.) In due time the nymph gave birth to a protector of the earth which is girt by the ocean. The father called his son *Pallava*, as he was lying on a couch (covered) with a heap of sprouts (*pallava*).

(V. 9.) From him came the ruler of the earth *Mahendravarman;* from him the valiant *Siṁhavarman;* from him *Arkavarman;* after him *Ugravarman;* then *Nandivarman* from *Śrîsiṁhavishṇu.*

(V. 10.) There arose that *Siṁhavarman*, in whose audience-hall darkness is transformed into dawn by the splendour of the jewels on the heads of many princes, and whom people call (the lord) of eighteen *lakshas* of horses and elephants.

(V. 11.) This hero for a long time protected the earth, whose garment is the ocean, whose pearl-necklace is the *Gaṅgâ*, and whose earrings are *Meru* and *Mandara*.

Once, while his back, his flanks, and his front were guarded by all his brave vassals and tributaries (*maṇḍalîka-sâmanta*), he marched to the peak of *Sumeru*, in order to place (there) the fame which he had acquired by conquering all quarters.[28] His elephants, which resembled the peaks of

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[28] That is, in order to put up a pillar of victory.

the mountain of the gods (*Meru*), tore with the claws (!) of their feet the gold,[29] and his horses, walking on those pieces (of gold), made the sky appear like a canopy by the gold-dust rising under their hoofs. There, in order to remove the fatigue caused by wandering over the whole world, he passed a few days, enjoying the shade of the yellow sandal-trees which grow on the slopes of gold. Then, having crossed the *Bhâgîrathî* (*Gaṅgâ*), the *Godâvarî* and the *Kṛishṇaverṇâ*, he perceived (a place sacred to) the lord *Vîtarâga* (Buddha), named the illustrious town of *Dhânyaghaṭa.* Having regarded it with curiosity, and having humbly approached and saluted the tutelar deities which were charged with the protection of the whole sacred place (*kshetra*), he listened to a discourse on the law[30] .... in a secluded spot. Having heard it, he saluted the highest-born[31] .... and spoke thus: "I also, O lord! (shall erect a statue?) of the lord at this very place, ornamented with jewels, gold, and silver." After he had thus spoken, the lord said: "Well, well, lay-worshipper *Siṁhavarman*! Here [at] the place sacred to the highest *Buddha* ....." Then having saluted ..... in *Dhânyaghaṭaka* .....

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[29] Namely, of which Mount Meru consists.

[30] See Childers, s. v. *dhammadesanâ.*

[31] With *aparajanman* compare *aparamabuddha* in line 45 of the present inscription. On *apara* as a synonym of *anuttama* see *Ind. Ant.*, Vol. XIV, p. 201, note 21.

Notes on the Madras species of Matuta.

(By J. R. HENDERSON, M.B., F.L.S.)

Among the many marine wonders drawn on shore in the nets of the Madras fishermen, few objects are more likely to attract the attention of the passer-by than the Crustaceans which form the subject of these notes. They are rendered conspicuous by very beautiful markings, a circular carapace with two lateral spines, and flattened swimming feet. The genus *Matuta* is eminently characteristic of the great Indo-Pacific region, to which indeed it is confined, the species occurring abundantly in shallow water throughout this area from the Red Sea to the coasts of Australia. At the same time there are few groups of Decapod Crustacea in which the determination of the species is a matter of greater difficulty, or in which authorities have differed more as to the specific or varietal value of forms. A glance at the history of the genus will bear out this statement.

In the second volume of his classical "Histoire Naturelle des Crustacés" (1837), Prof. H. Milne-Edwards admits but two species—*M. victor*, Fabr., and *M. lunaris*, Herbst.—those described by Leach and other writers he regards as merely varieties of one or other of the above. De Haan, in his great work on the Crustacea of Japan (1841), reduces the number to a single species—*M. victor*—and enumerates six varieties, without however assigning names to these; practically the same view is held by Prof. A. Milne-Edwards,[1] who refers all the previously described forms to *M. victor*. In 1876, Mr. E. J. Miers, with the rich collections of the

[1] *Nouvelles Archives du Muséum*, X., p. 54 (1874).

British Museum before him, published a "Revision of the genus Matuta" in the Transactions of the Linnean Society, which constitutes by far the most important contribution that has yet appeared towards our knowledge of this difficult group. In this valuable paper no less than nine species are described and figured, four previously known forms are restored to specific rank, including *M. victrix* (as it is now spelt) and *M. lunaris*, and, in addition, five new species are characterized for the first time. The chief value of Mr. Miers' work lies in the fact that reliable characters are pointed out, whereby a separation between closely allied species can be effected.

The genus *Matuta* is exceptional amongst the higher Crustacea in the fact that colour-markings afford trustworthy specific characters, the spots or lines on the carapace having a tolerably definite form and arrangement in each species. Further points of distinction are to be looked for in the relative proportion of the elevations on the surface of the carapace, and on its antero- and postero-lateral borders, the form of the front, but above all in the armature of the propodal joint of the chelipedes. In addition to the ordinary sexual differences, the males in several of the species possess a well-marked ribbed or beaded elevation on the outer surface of the dactylus of the chelipedes, which is either wanting or but slightly marked in the females. In all the species of *Matuta*, two striated areas, regarded by many authorities as stridulating organs, exist on the inner surface of the hand. These do not appear however to afford good distinguishing characters, contrary to what might be expected from a knowledge of their value in separating the species of *Ocypoda*.

As a result of my own necessarily limited investigations, I am enabled to record three well-marked species from Madras, viz., *M. victrix*, Fabr., *M. lunaris*, Herbst., and a third which is apparently new to science; doubtless increased

opportunities and more abundant material will bring other forms to light. In the short notes which follow, no attempt has been made to enter into the synonymy of the first two species, to ensure accuracy in this respect an appeal to the actual specimens described by most of the earlier writers would be necessary; nor do the notes attempt to compass all the distinguishing points of *M. victrix* and *M. lunaris;* they rather form a mere addendum to what has already been written on the subject. The examination of a large number of specimens in different stages of growth, has convinced me that the two, although closely allied in many respects, are to be regarded as distinct species; indeed, I have entirely failed to meet with individuals which could in any way be regarded as transitional.

1. *Matuta victrix*, (Fabr.) Miers.

Of a large series of individuals examined, the size (length of carapace) varied from 13·5 millim. to 40 millim. The markings are arranged in the form of minute crowded dots—occasionally when confluent forming small rings or semi-circles—more abundant on the anterior half of the carapace. With the exception that the markings are much less abundant, the youngest specimens examined agree in most respects with adults. The oval stridulating area contains 4—6 lines or ridges, the linear 8—9. In adult males, the second elevation on the outer surface of the hand is always very prominent and acute; a well-marked and somewhat curved ridge also extends from this spine to the tip of the immobile finger. In females and young males, the large spine is less strongly developed, but followed by three elevations, the second of which likewise takes the form of an acute spine, about half the size of the first, and the oblique ridge is otherwise scarcely represented.

In a specimen found by Dr. Thurston at Paumben, and which possesses all the more important characters of

M. victrix, the markings on the gastric region have arranged themselves in the form of three distinct circles. This variety (which may be designated var. *annulifera*) apparently stands in the same relation to *M. victrix*, that *M. circulifera*, Miers,[2] does to *M. lunaris*.

2. *Matuta lunaris* (Herbst.).

The smallest specimen examined has a length of carapace of 15 millim, the largest 36 millim. In all, the markings—which tend to form rings or short irregular lines—are more crowded on the anterior half of the carapace; posteriorly they show a marked tendency towards the formation of a series of longitudinal lines. In young individuals the colour markings are evident, though much less abundant, and the appearance of ring-like spots is well seen. The stridulating areas closely resemble those of *M. victrix*, with the exception that the oval one is usually composed of 4—5 ridges, and the linear of 8—10. In this species, as in the last, a beaded line is well seen on the outer surface of the movable finger of the male, but absent from the female. In the adult male, the outer surface of the hand is armed with two conical spines, the first short and triangular, the second more prominent; from the latter a raised line is continued along the outer surface of the immobile finger. In the females and young males, the second spine is followed by two or three pyramidal tubercles which take the place of the aforementioned ridge.

3. *Matuta Miersii*,[3] n. sp.

Description.—Carapace finely granulated around the dorsal tubercles, and towards the lateral spines, elsewhere

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[2] Founded on a single specimen from the Malaysian Seas described and figured in Ann. Mag. Nat. Hist., Ser. 5, vol. 5, pl. XIV, fig. 5, p. 27 (separate copy), 1880. According to Dr. J. G. DeMan it is to be regarded as a variety of *M. lunaris*.

[3] I have pleasure in associating this species with the name of my friend Mr. E. J. Miers, from whose revision of the genus I have received great assistance in the drawing up of these notes.

smooth and glabrous. Dorsal tubercles distinctly marked, each capped by a series of granulations. Lateral marginal spines acute, of moderate length and directed slightly forward. Antero-lateral border with about five small projections, followed by three large and prominent (especially the first and third) tubercles, in front of the lateral spines. Postero-lateral border with a raised finely beaded line, but without any trace of a postero-lateral tubercle. Front distinctly emarginate, the lobes rounded. Hand granulated externally, the upper border with three subequal, broadly conical, spines, below these, and on the outer surface, two rows of irregularly rounded tubercles. The external ridge in the male, with five granulated and pyramidal elevations, of which the second is large and conical, and the fourth is slightly larger than the third. Lower surface of the hand distinctly granulated, with two rows of tubercular processes (including that on the free border), separated by a shallow groove which is continued on to the outer surface of the immobile finger. The hand of the female similar to that of the male. Outer surface of the mobile finger, smooth and rounded in both sexes.

The markings on the carapace consist of minute reddish-brown spots—which with the aid of a lens may be seen in many cases to form incomplete rings—arranged so as to surround clear, somewhat circular, patches. In all the specimens examined, there is a light-coloured oval patch on the gastric region, between the two anterior dorsal tubercles.

Length of carapace of a male, 25 millim.

Breadth of carapace of the same (in front of the lateral spines), 25·3 millim.

Remarks.—This species belongs to the second section of the genus, in which the hand of the male is armed with a ridge of tubercles or spines, on the outer surface and parallel to the lower border, and in which the mobile finger is smooth or but faintly striated externally. Its two nearest allies are

apparently *M. maculata*, Miers, and *M. granulosa*, Miers. In the former, the dorsal tubercles are almost obsolete, the lateral spine is very long, and the front is either slightly rounded, or shows but slight emargination; in the latter, the carapace is coarsely granulated, the two anterior dorsal tubercles are wanting, and a thin ridge is present on the mobile finger of the male. The markings on the carapace bear some resemblance to those of *M. Picta*, Hess, (as figured by Miers), but many sufficiently obvious characters separate it from this species.

Habitat.—Madras, in shallow water. Less common than *M. victrix*, or *M. lunaris*.

Explanation of the Plate.

Fig. 1. *Matuta Miersii*, n. sp. (nat. size).
Fig. 2. Outer view of hand of the same.
Fig. 3. Abdomen of the same (male).
Fig. 4. Abdomen of the same (female).
Fig. 5. Young specimen of *Matuta victrix* (nat. size).
Fig. 6. Young specimen of *Matuta lunaris* (nat. size).

The Cosmogony of the Vedas.

(By the Rev. MAURICE PHILLIPS, *London Mission, Madras.*)

Section I.—Vedic Cosmogony not One Connected Narrative.

The cosmogony of the Vedas is not one connected narrative like that of the Bible, but many narratives or *hints* given by different poets at different times extending over a period of many centuries. The Rishis in attempting to construct a cosmogony, or in reproducing the almost forgotten traditions of the creation handed down from the ancestral home, necessarily gave their own conceptions, more or less coloured, according to their individual idiosyncrasies and the exigency of poetic language, which, according to Hindu notion, consists not so much in truth as in *rasa*, flavour or sensation. It is too much therefore to expect harmony between the various narratives, or even always between all the statements of any one poet in the same narrative. All that we can do is to analyse the different accounts, and point out the fundamental conceptions which underlie them, omitting what appears either too obscure for explanation or too puerile for remark.

Section II.—The Creation, the Work of an Intelligent Being.

All vedic cosmogonies recognise an omnipotent intelligent being as the author of the universe. That being is represented under names as various as the Hindu gods. For every god in the vedic pantheon was in his turn regarded as supreme, and, as such, the Author of the Universe. "All-seeing Visvakarman produced the earth and disclosed the sky by his might" (R.V., X. 81, 2). "He who produced heaven and earth must have been the most skilful artisan of

all the gods" (R.V., I. 160, 4). "Desire arose in 'that one' who was before all things, and this the wise have discerned to be the bond between nonentity and entity" (R.V., X. 129, 4). "Brahmanaspati blew forth all the births of the gods like a blacksmith" (R.V., X. 72, 2). "Hiranygarbha, the one born lord of things existing, arose in the beginning and established the earth and the sky" (R.V., X. 121, 1). "Prajāpati established all the worlds, and produced from his upper and lower breaths both gods and mortal creatures" (Sat. Br., X. 1, 3, 1). "Skamba established the earth, the sky, and the six wide regions" (A.V., X. 35). "Varuna by his might propped asunder the wide firmaments; he lifted on high the bright and glorious heaven; he stretched out apart the starry sky and the earth" (R.V., VII. 86, 1). "Indra established the earth and this sky, and, wonder working, produced the sun and the dawn" (R.V., III. 32, 8). "Surya, the most active of the active gods, produced the heaven and the earth which are beneficient to all" (R.V., I. 160, 4). "Agni upheld the broad earth, he supported the sky with true hymns" (R.V., I. 67, 3). "In the beginning Brahma was the source of all things! He created the gods and placed them in this world, in the atmosphere, and in the sky" (Sat. Br., XI. 2, 3, 1). "Rohita established heaven and earth, by him the sky was supported, by him the heaven" (A.V., XIII. 7).

Section III.—Three Modes of Creation.

While all vedic cosmogonies agree in ascribing the production of the universe to an omnipotent intelligent being, they differ as to the *mode* in which he produced it. Some represent it as the result of his power without pre-existing matter, or creation ἐξ οὐκ ὄντων; others, as the result of his power acting on eternally pre-existing matter, or creation ἐκ τῶν ὄντων; and others represent it as a phenomenal emanation of the deity, πρόοδος.

(1) *Creation ἐξ ὀυκ ὄντων, or creation out of nothing.*

The 129th hymn of the tenth book of the Rig-Veda is the most striking illustration of this "(1) There was then neither nonentity nor entity, there was no atmosphere, nor sky above. What enveloped (all)? Where in the receptacle of what (was it contained)? Was it water, the deep abyss? (2) Death was not then, nor immortality; there was no distinction of day or night. That One breathed calmly, by itself;[1] there was nothing different from It (that one), or beyond it. (3) Darkness there was; originally enveloped in darkness, this universe was undistinguishable water;[2] the empty (mass) which was concealed by a husk (or by nothingness) was produced, single, by the power of austerity (or fervour). (4) Desire first arose in It, which was the primal germ of mind. This the wise, seeking in their heart, have discovered by the intellect to be the bond between nonentity and entity. (5) The ray which shot across these things—was it above or was it below? There were productive energies and mighty powers; nature (svadha) beneath, and energy (prayati) above. (6) Who knows, who here can declare, whence has sprung, whence this creation? The gods are subsequent to its formation; who then knows from what it arose? (7) From what source this creation arose and whether (any one) created it or not—He who in the highest heaven is its ruler, he verily knows, or (even) he does not know."[3]

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[1] "Breathed without afflation, single with (svadha) her who is sustained within him."—*Colebrooke.*

"Breathed calmly, self-supported."—*Muir.*

"Breathed breathless by itself."—*Max Müller.*

"Breathed calmly, self-contained."—*Monier Williams.*

[2] "There was a time in which all was darkness and water."—*Babylonian Tradition of the Creation.*

[3] नासदासीन्नो सदासीत्तदानीं नासीद्रजो नो व्योमा परो यत् ।
किमावरीवः कुह कस्य शर्मन्नभः किमासीद्गहनं गभीरं ॥ १ ॥
न मृत्युरासीदमृतं न तर्हि न रात्र्या अह्न आसीत्प्रकेतः ।

Here we are carried back to a time long before the first verse in Genesis when there was neither "nonentity (asad, *τὸ μὴ ὄν*) nor entity" (sad, *τό ὄν*). From the inability of the human mind to conceive a state that was neither nothing nor something,[4] the Atharva-Veda identifies this remote "nonentity" with Skambha, a personification of the divine power which supports the universe; and the Chandogya Upanishad doubts that there ever was a period without entity (Muir, Vol. 4, p. 10). The vedantists explain *sad* as the supreme being manifesting himself by creation; and *asad* as mere forms or illusions by which he deceives the senses. What then does the poet mean by the phrase "There was then neither nonentity nor entity"? Does he mean to say that there was neither absolutely? So evidently thought the

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आनीदवातं स्वधया तदेकं तस्माद्धान्यन्न परः किं चनास ॥ २ ॥
तम आसीत्तमसा गूळ्हमग्रेऽप्रकेतं सलिलं सर्वमा इदं ।
तुच्छ्येनाभ्वापिहितं यदासीत्तपसस्तन्महिनाजायतैकं ॥ ३ ॥
कामस्तदग्रे समवर्तताधि मनसो रेतः प्रथमं यदासीत् ।
सतो बंधुमसति निरविंदन्हृदि प्रतीष्या कवयो मनीषा ॥ ४ ॥
तिरश्चीनो विततो रश्मिरेषामधः स्विदासी३दुपरि स्विदासी३त् ।
रेतोधा आसन्महिमान आसन्त्स्वधा अवस्तात्प्रयतिः परस्तात् ॥५॥
को अद्धा वेद क इह प्र वोचत्कुत आजाता कुत इयं विसृष्टिः ।
अर्वाग्देवा अस्य विसर्जनेनाथा को वेद यत आबभूव ॥ ६ ॥
इयं विसृष्टिर्यत आबभूव यदि वा दधे यदि वा न ।
यो अस्याध्यक्षः परमे व्योमन्त्सो अंग वेद यदि वा न वेद॥ ७ ॥

[4] Wo are utterly unable to realize in thought the possibility of the complement of existence being either increased or diminished. We are unable, on the one hand, to conceive nothing becoming something, or, on the other, something becoming nothing."—*Sir W. Hamilton's Lectures on Metaphysics, Vol. II, p. 377.*

sages of the Atharva-Veda and the Chandogya Upanishad. But this is a mistake; for he postulates the existence of "that One breathing breathless by Itself," *i.e.*, the unconditioned existing alone by his own inherent power without the accidents of time and space which are the conditions of our life.[5] Does he mean that there was neither *relatively ?* This doubtless is his meaning; and in this sense the phrase is perfectly true, for we can know neither "entity" nor "nonentity" except as they are related to one another. The existence of the one necessarily implies the existence of the other; and hence without a knowledge of both we can know neither.[6] And since there was then no entity, no trace, no atom of what afterwards became the world, the poet asserts with a philosophical precision with which we are scarcely prepared to meet in that remote age, "there was neither nonentity nor entity." This meaning is confirmed by R.V., X. 72, 1, "In the former age of the gods, the existent sprang from the non-existent," *i.e.*, whatever now visibly exists had at one time no existence; and by the Sat. Br., "In the beginning this universe was indeed non-existent," as well as by the Aitareya Āranyaka, "Originally this (universe) was indeed soul only : nothing else whatsoever existed active or (inactive)." In the same sense the poet declares that there was neither "death" nor "immortality;" for one is the negative of the other, and hence without a knowledge of both we can know neither; and since there was no "death," inasmuch as there was nothing to die, there could have been no "immortality" or the opposite of death.

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[5] So it is explained in the Satapatha Br., X. 5, 1. "In the beginning this universe was, as it were, and was not, as it were. Then it was only that mind. Wherefore it has been declared by the rishi 'there was then neither nonentity nor entity,' for mind was, as it were, neither entity nor nonentity."

[6] "The judgment cannot affirm or deny one notion of another, except by uniting the two, in one indivisible act of comparison."—*Sir W. Hamilton's Lectures on Metaphysics, Vol. I, p.* 68.

Between the statements made in the two first and third verses, we must logically place the action of the fourth verse, which produced the "undistinguishable water" of the third; an action identical with the creative act of Genesis i. 1, which produced "the heaven and the earth" in a chaotic state. The cause of this action was the determination of the Infinite will. "Desire arose in It which was the primal germ of mind;" *i.e.*, which to us is the first manifestation of conscious mind. "This the wise, seeking in their heart, have discerned by the intellect to be the bond between nonentity and entity;" *i.e.*, the will of God was the cause of the existent springing from the non-existent. This is only another form of the Hebrew expression, "and God said let there be . . . . . . and there was." The same idea is expressed in the Aitareya Āranyaka, "He thought, I will create worlds, thus he created these various worlds; water, light, mortal (beings) and the waters;" and in the Aitareya Brāhmana, "Prajāpati was in the beginning but one. He uttered the Nivid (a sacrificial formula) and all things were created." Again, "The word is the creator of the universe, the powerful one; for by the word is all this made" (*vaca hidam sarvam kritam*—S.P.Br., VIII. 1, 2, 9). How wonderfully this language agrees with the declaration of the Psalmist— "By the word of the Lord were the heavens made; and all the host of them by the breath of his mouth." "He spake, and it was done, he commanded, and they were created" (Ps. xxxiii, 6, 9; cxlviii, 5). The same idea is also found both among the Iranians and semi-civilised races of Western Australia. In the sacred books of the former it is said that Ahura Mazda created the world by means of the Yathā-ahū-vairyō prayer; and the Roman Catholic missionaries ascertained that the latter believe in an omnipotent being who created the heaven and the earth by breathing; whose name is Motogon. To create the earth, he said, "Earth come forth! And he breathed, and the earth was created.

So with the sun, moon and all things" (M.M.'s *Hibbert Lectures*, pp. 16, 17).

The water and the darkness of this hymn correspond to the *thohu vabohu*, "without form and void," of Genesis and to the chaos of the Greeks. "This universe was undistinguishable water enveloped in darkness." It was an "empty" "or shapeless mass" concealed by the "deep abyss" like grain in the "husk;" but brought forth a beautiful world by "the power of austerity" or "contemplation" as Colebrooke translates it; *i.e.*, by the mighty will of "That One" who designed it. For, "there were productive energies, and mighty powers;" *svadha*, nature, beneath, and *prayati*, energy, above. Yes, there was *svadha* or chaos beneath, and there was the mighty "energy" of the Spirit of God moving on the face of the waters above, bringing order from confusion, cosmos from chaos, and breathing forth light and life everywhere.[7]

Max Müller and Monier Williams see in *svadha*, beneath, and *prayati*, above, the first dim outline of the idea that the creator willed to produce the universe through the agency and co-operation of a female principle; an idea which afterwards acquired more shape in the supposed marriage of heaven and earth. It is more probable that this idea originated in a *misunderstanding* of this hymn, or of the tradition on which it is based.

The poet closes his sublime narrative of the creation in an unexpectedly sad and disappointing tone. After the graphic description he has given of the origin of the universe, he finishes by intimating that he does not know after all "from

[7] In the Taittirya Sanhita, VI. 4–8, we read: "This world had neither day nor night, but was (in that respect) undistinguished." The gods said to Mitra and Varuna, "make a separation . . . Mitra produced the day and Varuna the night" (Muir's S.T., Vol. 5, p. 59); and in the Aitareya Âryanaka we read: "Self-brooded over the water." From the water thus brooded on, matter (murti) was born.

what source this creation arose, and whether any one created it or not!" All he can affirm with confidence is that "He who is in the highest heaven is its ruler, He verily knows or (even) He does not know." Another poet in the same melancholy strain of ignorance and uncertainty asks, "What was the forest, what was the tree, from which they fashioned the heaven and the earth? Enquire mentally, ye sages, what that was on which he took his stand when establishing the worlds" (R.V., X. 31, 7); and similarly another poet, "Which of these two (heaven and earth) was the first and which the last? How have they been produced; declare, sages, who knows this?" (R.V., I. 185, 1). What a sad comment this is on the words of the Apostle Paul—"The world by wisdom knew not God!" (1 Cor. i., 21). Speculative and religious truths beyond the range of experience cannot be known with that degree of certainty which can satisfy the human mind, except by an authoritative revelation from the Author of our being. Even Socrates declared that he knew only this, that he knew nothing!

This is the most ancient and the most vivid reproduction of the primitive faith respecting the origin of the universe. It contains all the essential elements of the Mosaic narrative, differing only in being more vague and given with less certainty. The fundamental idea that the eternally self-existent One created the world by the power of his own will without pre-existent matter, and the chronological order —first, will or desire, then chaos or undigested matter, and, lastly, this beautiful world,—are identical in both. Now this idea of creation from nothing cannot be accounted for on natural grounds, for there is nothing in nature to indicate that something can be produced from nothing. The constitution of the human mind is such that it cannot think of anything beginning to exist in essence, but only in form. It is evident, therefore, that the idea of creation from nothing is not the product of reason, but of divine revelation.

We learn from the old Norse Eddas of Iceland that the Teutonic Aryans carried away from the original home the same belief in the origin of the universe. The first poem in the first part of the Elder Edda, which contains the oldest traditions of the Germanic races, is the Valupsa, or wisdom of Vala. Vala was a prophetess and thus describes the creation of the world:—

"I command the devout attention of all noble souls,
Of all the high and the low of the race of Heimdall,
I tell the doings of the All Father,
In the most ancient sagas which come to my mind."

"There was an age in which Ymir lived,
When was no sea, nor shore, nor salt waves;
No earth below, nor heaven above,
No yawning abyss and no grassy land."

"Till the sons of Bors lifted the dome of heaven
And created the vast Midgard (earth) below;
When the sun of the south rose above the mountains
And green grasses made the ground verdant."

(2) *Creation ἐκ τῶν ὄντων, or creation from existing matter.*

(1) "Hiranyagarbha arose in the beginning; he was the one born lord of things existing. He established the earth and this sky: to what god shall we offer our oblation? (2) He who gives breath, who gives strength, whose command all (even) the gods reverence, whose shadow is immortality, whose shadow is death: to what god shall we offer our oblation? (3) Who by his might became the sole king of the breathing and winking world, who is the lord of this two-footed and four-footed (creation): to what god shall we offer our oblation? (4) Whose greatness these snowy mountains, and the sea with the rasa (river) declare, of whom these snowy regions, of whom they are the arms: to what god shall we offer our oblation? (5) By whom the sky is fiery and the earth fixed, by whom the firmament and the heaven were established, who in the atmosphere is the measurer of

aerial space : to what god shall we offer our oblation ? (6) To whom heaven and earth, sustained by his succour, looked up, trembling in mind ; over whom the sun shines : to what god shall we offer our oblation ? (7) When the great waters pervaded the universe, containing an embryo and generating fire, thence arose the one spirit (asu) of the gods : to what god shall we offer our oblation ? (8) He who through his greatness beheld the waters which contained power, and generated sacrifice, who was the one god above gods : to what god shall we offer our oblation ? (9) May he not injure us, he who is the generator of the earth, who ruling by fixed ordinances produced the heavens, who formed the great and brilliant waters : to what god shall we offer our oblation ? (10) Prajāpati, no other than thou is lord over all these created things; may we obtain that, through desire of which we have invoked thee; may we become masters of riches "[8] (R.V., X. 121).

Max Müller says respecting this hymn, that "the idea of one god is expressed with such power and decision, that it

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[8] हिरण्यगर्भः समवर्तताग्रे भूतस्य जातः पतिरेक आसीत् ।
स दाधार पृथिवीं द्यामुतेमां कस्मै देवाय हविषा विधेम ॥ १ ॥
य आत्मदा बलदा यस्य विश्व उपासते प्रशिषं यस्य देवाः ।
यस्य छायामृतं यस्य मृत्युः कस्मै देवाय हविषा विधेम ॥ २ ॥
यः प्राणतो निमिषतो महित्वैक इद्राजा जगतो बभूव ।
य ईशे अस्य द्विपदश्चतुष्पदः कस्मै देवाय हविषा विधेम ॥ ३ ॥
यस्येमे हिमवंतो महित्वा यस्य समुद्रं रसया सहाहुः ।
यस्येमाः प्रदिशो यस्य बाहू कस्मै देवाय हविषा विधेम ॥ ४ ॥
येन द्यौरुग्रा पृथिवी च दृळ्हा येन स्वः स्तभितं येन नाकः ।
यो अंतरिक्षे रजसो विमानः कस्मै देवाय हविषा विधेम ॥ ५ ॥

will make us hesitate before we deny to the Aryan nations an instinctive monotheism;" and Monier Williams remarks, that "it furnishes a good argument for those who maintain that the purer faith of the Hindus is properly monotheistic" (Hist. Anc. Sans. Lit., p. 568. Indian Wisdom, p. 23).

"The whole of this hymn is found repeated in the Vājasaneyi-Sanhitā, and most of the verses recur in the Atharva-Veda" (Muir's Sans. Texts, Vol. IV, p. 15). The last verse is rejected by most critics as being the production of a later age.

According to this hymn the creator, Hiranyagarbha, arose in the beginning from the great waters which pervaded the universe, the "undistinguishable water" of R.V., X. 129, 3, or chaos, and so became "the one born lord of things existing." The idea is that the primeval waters generated a "golden embryo," and that from this "embryo" the creator was born, or took bodily form, in order to transform chaos into cosmos; and hence is denominated, Hiranyagarbha, the "golden embryo," which also may be translated "the golden or the bright child." And hence it is said in the Atharva-

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यं क्रंदसी अवसा तस्तभाने अभ्यैक्षेतां मनसा रेजमाने ।
यत्राधि सूर उदितो विभाति कस्मै देवाय हविषा विधेम ॥ ६ ॥
आपो ह यद्बृहतीर्विश्वमायन्गर्भं दधाना जनयंतीरग्निं ।
ततो देवानां समवर्ततासुरेकः कस्मै देवाय हविषा विधेम ॥ ७ ॥
यश्चिदापो महिना पर्यपश्यद्दक्षं दधाना जनयंतीर्यज्ञं ।
यो देवेष्वधि देव एक आसीत्कस्मै देवाय हविषा विधेम ॥ ८ ॥
मा नो हिंसीज्जनिता यः पृथिव्या यो वा दिवं सत्यधर्मा जजान ।
यश्चापश्चंद्रा बृहतीर्जजान कस्मै देवाय हविषा विधेम ॥ ९ ॥
प्रजापते न त्वदेतान्यन्यो विश्वा जातानि परि ता बभूव ।
यत्कामास्ते जुहुमस्तन्नो अस्तु वयं स्याम पतयो रयीणां ॥ १० ॥

Veda, "In the beginning the waters producing a child, brought forth an embryo, which as it was coming into life was enveloped in a golden covering" (Muir's Sans. Texts, Vol. IV, p. 16).

From this it is evident (1) that when Hiranyagarbha was born the universe was in a chaotic state pervaded with water; (2) that he rose from an embryo generated by the water when the earth was "void and without form;" and (3) that he made the world into its present form from the existing shapeless chaos. "For he who is god above all gods established the earth and the sky;" he "formed the brilliant waters" and "the snowy mountains;" and hence all creation unite in "declaring his greatness."

Was this chaos eternally self-extistent independently of Hiranyagarbha? or was there a time in the unspeakable past when he produced it? or did the chaotic waters by some unknown law of development gradually and spontaneously produce him? or were both eternally and independently co-existent? It appears from this hymn that both were regarded as eternally and independently co-existent. It is stated in the eighth verse that Hiranyagarbha "through his greatness beheld the waters which contained power," *i.e.*, "the great waters" of verse 7 which "pervaded the universe" or chaos. He must have beheld these before he was born from the golden embryo, for the "great waters" of these verses are different from the "great and brilliant waters" of verse 9. The former are the great primeval waters from which the world was made; and the latter are the seas, the lakes and the rivers, "formed" by the creator. Of course it might be affirmed that he beheld the great chaotic waters after he was born; but the former view is more in harmony with other vedic passages. The Atharva-Veda, 2, 6, says, "In the beginning the waters, immortal, and versed in the sacred ceremonies covered the universe containing an embryo; over these divine waters was the

god," *i.e.*, before he was born in the embryo. Here both the creator and the immortal waters are represented as separate independent existences in the "beginning," and presumably from eternity. The same idea appears in R.V., X. 82, "That which is beyond the sky, beyond this earth, beyond gods and spirits; what earliest embryo did the waters contain in which all the gods were beheld?" The waters contained that earliest embryo in which all the gods were collected. One receptacle rested upon the navel of the unborn, wherein all the worlds stood. "Ye know not him who produced all things." What the earliest embryo contained in which all the gods were collected, inasmuch as it contained their creator, "the sole life of the bright gods," was "that which is beyond the sky, beyond this earth, beyond gods and spirits," he who "produced these things" and not he who was produced by them. Here again the existence of the author of the universe is represented as separate from, and independent of, the original chaos. The same idea underlies R.V., X. 72, 6, 7, "When, gods, ye moved, agitated upon those waters, then a violent dust issued from you, as from dancers. When gods, ye, like strenuous men, replenished the worlds, then ye drew forth the sun which was hidden in the (aerial?) ocean." Besides, Varuna, Indra and others are represented as establishing and supporting the heavens above, fixing and directing the sun in the sky, and setting limits to the earth; assuming that the objects themselves in some shape were pre-existent.

It should be observed, however, that there is a legend in the Satapatha Brāhmana, in which the primeval waters are represented as generating an egg, and the egg bringing forth Prajāpati, the creator of the world. "In the beginning this universe was waters, nothing but water. The waters desired, 'how can we be produced?' so saying they toiled, they performed austerity. While they were performing austerity, a golden egg came into existence. From it, in a year, a

man (*purusha*) came into existence, who was Prajāpati. He divided this golden egg. There was then no resting place for him. He therefore floated about for the space of a year, occupying this golden egg. In a year he desired to speak. He uttered *bhuh*, which became this earth; *bhuvah*, which became this firmament; and *svah*, which became that sky" (Muir's Sans. Texts, Vol. IV, p. 21).

In this account, probably, the author of the primeval waters is overlooked rather than denied. For certain it is that this materialistic doctrine was never popular in India. Hindus of the vedic age believed either in creation from nothing by the exertion of divine power, or in creation from chaos after the birth of the creator from the "golden embryo," or in creation as a phenomenal emanation; and post-vedic cosmogonies combine the two first, with the exception of the Vedanta which adopts the last.

According to Manu, the Harivamsa, and the Puranas, the Deity was prior to chaos; he created the primeval waters by a thought, and deposited a seed in them which became a golden egg, resplendent as the sun, in which he himself was born as Brahma, the progenitor of all worlds. . . . . (5) "This universe was enveloped in darkness, unperceived, undistinguishable, undiscernible, unknowable, as it were entirely sunk in sleep. (6) Then the irresistible self-existent lord, undiscerned, causing this universe with the five elements and all other things to become discernible, was manifested dispelling the gloom. (7) He who is beyond the cognizance of the senses, subtle, undiscernible, eternal, who is the essence of all beings, and inconceivable, himself shone forth. (8) He desiring to produce various creatures from his own body, first with a thought created the waters, and deposited in them a seed. (9) This (seed) became a golden egg, resplendent as the sun, in which he himself was born as Brahma, the progenitor of all the worlds. (10) The waters are called *nārā*, because they are the offspring of *Nārā*; and since they were

formerly his receptacle, he is therefore called Nārāyana. (11) Being formed by that first cause, undiscernible, eternal, which is both existent and non-existent, that male (*purusha*) is known in the world as Brahma. (12) That lord having continued a year in the egg, divided it into two parts by his mere thought. (13) With these two shells he formed the heavens and the earth; and in the middle he placed the sky, the eight regions, and the eternal abode of the waters" (Manu).

Kulluka, an old commentator, thus annotates on verse 9. "That (seed) became a golden egg," &c. That seed by the will of the deity became a golden egg. Golden, *i.e.*, as it were golden, from the quality of purity attaching to it, and not really golden, for since the author proceeds to describe the formation of the earth from one of the halves of its shell, and we know by ocular proof that the earth is not golden, we see that a mere figure of speech is here employed . . . In that egg Hiranyagarbha was produced, *i.e.*, entering into the soul—which was invested in a subtle body—of that person by whom in a former birth the deity was worshipped, with a contemplation on distinctness and identity expressed in the words "I am Hiranyagarbha, the supreme spirit himself became manifested in the form of Hiranyagarbha."

There is a legend in the Satapatha Brāhmana to the same effect, in which the gods are said to have made Prajāpati, that he generated the waters; and desiring to be reproduced from them, entered the waters, when an egg arose. "He pondered on it. He said 'Let there be, let there be!' again, 'Let there be!' and all things appeared."

In the 9th hymn of the 10th book of the R.V., the gods are represented as having fashioned the universe from the dismembered limbs of Purusha, the primeval male whom they sacrificed. "The moon was produced from his mind (manas), the sun (Surya) from his eye, Indra and Agni from his mouth, and Vayu from his breath. From his navel

came the atmosphere, from his head the sky, from his feet the earth, from his ears the four quarters, so they formed the worlds." From him also were produced the different castes and animals.

It is obvious that this second narrative of the creation is a corruption of the first. The hymns which contain it are of later date, as is proved by the abstract names of the gods mentioned in them, such as Hiranyagarbha, Visvakarman, and Prajāpati. The primitive narrative was either greatly obscured in the memory of, or partly rejected by, the propounders of this theory. That god produced the chaotic fluid before he formed the world was either forgotten or rejected, on the ground that it was contrary to experience to produce something out of nothing. Hence chaos is represented as existing together with, and independently of, the creator; and the creator, as assuming discernible form in a "golden embryo" in order to fashion the universe. According to this theory he is nothing more than the architect or the maker of the world from pre-existing matter. This was also the Zend idea of creation, and hence the phrase "created by Mazda," is Mazda-Dhata, established or arranged by Mazda. "The firmament," the infinite time, and the air which work on high are called "self-created."

The idea that the creator rose from a "golden embryo," or "golden egg," probably orginated in a dim recollection of the primitive account that the "Spirit of God moved on the face of the waters" (Genesis i. 2). For the Hebrew verb, *racaph*, translated "moved," means to "flutter," to "hover," and to "brood" as of a bird over its nest. "As an eagle stirreth up her nest, fluttereth over her young," &c. (Deut. xxxii. 11). The word translated "fluttereth" here is the same as that translated "moved" in Genesis i. 2. If therefore the primitive account was, that god in fashioning the world "fluttered" or "brooded" over chaos like a bird over its nest, what was more natural than that in the course of

time the simile involved in the action should have been forgotten and God actually made to rise from the "golden embryo," or to be born from the "golden egg," "generated by the waters"?

And as the Teutonic Aryans carried away the primitive belief respecting the creation of the world to the north of Europe, so the Greek Aryans carried away the more recent to the south, or elaborated a similar theory there. Plato says, "that all wise men, with the exception of Parmenides, thought that all things proceeded from water, and that generation was a sort of flowing motion." Aristophanes gives the particulars as follows:—

"First all was chaos, one confused heap;
Darkness enwrapped the disagreeing deep;
In a mixed crowd the jumbling elements were,
Nor earth, nor air, nor heaven did appear;
Till in this horrid vast abyss of things,
Teeming night spreading o'er her coal black wings
Laid the first egg; whence after time's due course,
Issued forth love (the world's prolific source)
Glistening with golden wings; which fluttering o'er
Dark chaos, gendered all the numerous store of animals
and gods, &c." [9]

Here night and chaos are represented as the first substances existing alone. They laid an egg, whence love was produced,—the "desire" of R.V., X. 129-4, and the "golden child" of R.V., X. 121-1, and the "Spirit of God" of Genesis i. 2,—which, fluttering o'er dark chaos, gendered heaven, earth, animals and gods.

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[9] Χάος ἦν καὶ νυξ, ἔρεθὸς τε μέλαν πρῶτον καὶ Ταρταρος εὐρύς.
Γῆ δ, οὐδ' ἀὴρ, αὐδ' οὐρανὸς ἦν ἐρέθους δ' ἐν ἀαπείροσι κόλποις
Τίκτει πρώτιστον ὑπηνέμιον νὺξ ἡ μελανόπτερος ὠόν.
'Εξ οὗ περιτελλομέναις ὥραις ἔθλαστεν "Ερως ὁ ποθεινός.
Στίλθων νῶτον πτερύγοιν χρυσαῖν εἰκὼς ἀνεμώκεσι δίναις
Οὗτος δέ χάει πτερόεντι μιγεὶς νυχίῳ, κατὰ Τάρταρον εὐρὺν,
'Ενεόττευσε γένος ἡμέτερον, καὶ πρῶτον ἀνήγαγεν ἐς φῶς,
Πρότερον δ' οὐκ ἦν γένος ἀθανάτων, πρὶν "Ερως συνέμιξεν ἅπαντα.

It should be stated that Hindu Pundits do not believe that the Vedas contain two or more theories of the creation of the world. They maintain that there is only one theory viewed from different standpoints. Hence they explain "nonentity" as a state in which name and form (nāma and rūpa) were not developed, and not absolute nullity like that expressed in the phrase "a hare's horns;" and Hiranyagarbha born from the "golden embryo" as the abstract neuter Brahma assuming personality in the form of the male Brahma in order to transform what was neither "nonentity" nor "entity" into the visible universe, having names and forms, such as earth, sky, and water. This, however, is a speculation of a later age, when the simple meaning of the hymns had been forgotten and the Hindu mind profoundly affected with philosophy.

(3) *Creation, πρόοδος, or a phenomenal emanation of the deity.*

When the Sages of the Upanishads had attained the highest philosophical unity, when they had merged all the elemental gods and all existences, material, mental and spiritual, in one great entity, *Atma*, *Brahma*, *Prana*, *Purusha*, or *Sat*, there was no room for a real objective creation, such as the two we have already considered. What we call creation, therefore, was conceived of as a kind of phenomenal emanation or illusory manifestation of the one great reality. Nothing really exists except the great spirit or self, and the universe is nothing more than its manifestation, its body, which it draws from its own substance, and again absorbs into it as the spider spins forth and draws back the thread of its web. "This whole universe is filled by this person (Purusha) to whom there is nothing superior, from whom there is nothing different, than whom there is nothing smaller or larger, who stands alone, fixed like a tree in the sky." "By means of thoughts, touching, seeing, and passions, the incarnate self assumes successively in

various places various forms, in accordance with his deeds, just as the body grows when food and drink are poured into it." "That incarnate self according to his own qualities chooses (assumes) many shapes, coarse or subtile, and having himself caused his union with them, he is seen as another and another, through the qualities of his acts, and through the qualities of his body."[10] And so this great Atma is both the material and efficient cause of all finite existences. "As from blazing fire, sparks, being like unto fire, fly forth a thousandfold, thus are the various beings brought forth from the imperishable and return hither also." "The sky is his head, his eyes the sun and the moon, the quarters his ears, his speech the Vedas, the wind his breath, his heart the universe; from his feet came the earth; he is indeed the inner self of all things."[11] "As all spokes are contained in the axle and in the felloe of a wheel, all beings and all selfs are contained in that self."[12]

Professor Max Müller, in his Introduction to Vol. I of the "Sacred Books of the East," says, that "Atman was looked upon at the same time as the starting point of all phenomenal existence, the root of the world, the only thing that could truly be said to be, to be real and true. As the root of all that exists, the Atman was identified with the Brahman, which in Sanskrit is both masculine and neuter, and with the Sat, which is neuter only, that which is, or Saty, the true, the real. It alone exists in the beginning and for ever; it has no second. Whatever else is said to exist, derives its real being from the Sat. How the one Sat becomes many, how what we call creation, which they call emanation (πρόοδος) constantly proceeds and returns to it, has been explained in various more or less fanciful ways by

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[10] Svetâsavatara Upanishad, III. 9; V. 11, 12. Brihadaryanaka Up., 8 Brâhmana.

[11] Mundaka Up.

[12] Brihadaryanaka Up., II. 5, 15.

ancient prophets and poets. But what they all agree in is this, that 'the whole creation, all plants, all animals, all men are due to the one Sat, are upheld by it, and will return to it.'"

This theory of creation is the logical outcome of Monism or Pantheism. And as Monism or Pantheism is far inferior, from a religious point of view, to the idea of personal gods, however imperfect, so we may remark that this theory of creation is equally inferior to either of the two older ones which appear in the Rig-Veda. The identity of cause and effect, the subject and object, which appears in the Upanishads was made the fundamental doctrine of the Vedanta or Non-dual philosophy, a philosophy the most *widely accepted in India* at the present day.

The Pearl Oyster of the Gulf of Manaar: *Avicula (meleagrina) fucata.*

(By HENRY SULLIVAN THOMAS, Esq., M.C.S., F.L.S., F.Z.S.)

There are numerous pearl bearers, some marine, some fresh-water, some oysters, some mussels; but the animal that yields the pearl with which we are most conversant, because of its being the pearl of the best lustre, is the pearl oyster of the Gulf of Manaar.

In common parlance it has always been known as the pearl oyster, because the general form of the shell is that of an oyster, the valves being nearly semi-circular as in the common edible oyster (*Ostrea edulis*) of England, and not elongated as in the equally familiar edible mussel (*Mytilus edulis*). The valves are also more flattened than in the more convex shelled common mussel aforesaid. The presence of a *byssus,* however, declares it to be a mussel; it belongs to the genus *Avicula,* and the growth of fine sea weed or *fucus,* with which the shell is covered, has presumedly given this mussel its distinctive appellation *fucata;* and the second name *meleagrina,* sometimes retained in brackets, is probably so retained to connect it with Lamarck's classification *meleagrina.* It is however now classed by Reeve as *Avicula,* and is to be found in Tryon's Conchology, 1884, under—

Class—*Pelecypoda,* his name for Lamellibranchiata.
Order—*Asiphonida.*
Sub-order—*Heteromyaria,* often included in Monomyaria.
Family—*Aviculidæ.*
Sub-family—*Aviculinæ.*
Genus—*Avicula.*
Species—*Avicula (meleagrina) fucata.*

Not to lose the researches of our predecessors it may be well here to mention that Dr. Kelaart and many other naturalists have written valuable contributions, referring to it under the name *Meleagrina margaritifera*. The error of referring the chief of pearl bearers to the name *margaritifera* was a natural one, but I have the authority of Mr. Edgar A. Smith, Conchologist of the British Museum, for terming the animal with which we have to do *Avicula* (*meleagrina*) *fucata*, and it is so named in the British Museum cases.

Having thus come to a definite understanding about the animal we are discussing I may mention that, as the term "spat" is somewhat laxly used popularly to cover the whole young state of the oyster, I apply it only to the stage in which, after having passed from ova to the swimming larval form, it is precipitated to the bottom and becomes spat in my limited sense.

The Exterior.

It is well to note the chief features of the shell of the pearl oyster, both to distinguish it from the edible oyster, and to know it, when less than a quarter of an inch broad, from a shell that has been mistaken for oyster spat. In the edible oyster the hinge point is an angular prominence called the beak or *umbo*, and the inequivalved and approximately oval-shell falls from it at right angles, one valve or side of the shell being flat and thin, the other valve thick and highly convex. The pearl oyster has the same beak, or *umbo*, the embryonic shell of bivalves, but it is prolonged by *ears* into a straight hinge from which the nearly equivalved shell falls obliquely, the length or height of the hinge being very nearly the same as the breadth of the shell taken rectangularly from the hinge to the furthest point of contour. Below the shorter ear is a notch, which is the byssal sinus; both valves are slightly convex, and nearly equally so, and both are of about the same thickness. In the edible oyster

the left valve is the larger and the thicker and lies undermost, and, except when free, immovably cemented for life to a rock. In the pearl oyster it is the short ear of both valves that is weighted so as to fall downwards conveniently for the foot to catch the bottom, while the other prolonged ear is lightened presumedly for the same purpose of facilitating the falling of the animal foot-downwards. The weighting of the byssal and foot ear also provides strength in the testaceous covering just where force is exerted by the animal, for it is from this point that the shell and animal is moved and moored. The shell of the young pearl oyster is covered with numerous thin flattened spines radiating in a series of lines from the *umbo,* proceeding one above the other from the irregularly concentric lines which mark the periodicity of the growth of the shell from contour to contour, and standing only just free from each other and overlapping the shell. They are said not to be present in the older pearl oyster. I had no means of observing for myself, for we came on no fullgrown pearl oysters. The whole shell of the immature pearl oyster, with the exception of the *umbo* and the byssal ear, is very thin and fragile, but in the mature oyster the shell thickens and becomes consequently heavier and stronger. The results of this arrangement in the changed habits and greater protection of the animal will be seen hereafter.

The Interior.

Contrary to the rule with lamellibranchiate mollusks, the pearl oyster, though a mussel, resembles the English oyster in being *monomyary* or one-muscled, that is, it has but one *adductor* muscle with which to bring its valves together at will; when this muscle is relaxed, the shell opens involuntarily from the thick elastic cushion formed by the middle of the hinge ligament being compressed between the valves, and acting like a spring cushion to open them. Thus

when the valves are open for breathing and feeding, the animal is at rest, and has to exert its strong *adductor* muscle only when on its guard against enemies. The pearl oyster breathes and feeds like the English oyster which is so admirably described, with excellent illustrations, by Professor Huxley in the October and November numbers of 1883 of the *English Illustrated Magazine.* Both are alike *acephalous,* or headless, and eyeless, except in the larval state, though both have mouths and *labial palps* or lips like flaps with which to select food and convey it to the mouth. Both are extraordinarily fertile, the pearl oyster spawning, according to Dr. Kelaart, almost from its birth, certainly during the months of March, April, May and June, not from July to September, the gap from October to March being unknown. One pearl oyster contained, under Dr. Kelaart's micrometer, as many as twelve million ova. The larva of both floats and has been presumed to be at the mercy of the currents, a presumption to which in my view a certain amount of reservation is to be attached.

Migratory habits.

The migratory powers of the pearl oyster as distinguished from the sedentary habit of the edible oyster arrest our special interest. From the date of its birth the pearl oyster's first migratory property is to float on the surface, and be carried to and fro by the superficial currents. In some measure therefore it probably depends on what are the upper currents that prevail during the days that it is afloat, where the *larva* is when it comes to an age to be precipitated as spat, though it seemingly has also the means of propelling itself in the water by the action of a natatory organ called the *velum,* like the wheel at one end of the *rotiferæ,* so that it can direct its course to any particular object that it may wish to adhere to. I say "seemingly," because it was only through a hand-glass that I had but once the opportunity

of seeing these forms, and I could not turn aside from what I had in hand to place them under a microscope, and as far as I had opportunity of seeing, they exactly answered to Professor Huxley's description of the *larva* of the edible oyster. I say also "in some measure," above, because I do not look upon it as a foregone conclusion that these little creatures *must* be borne by the currents; they may be able to swim against them, as butterflies can in an astonishing manner fly against a very strong wind. That butterflies can so fly is a fact in natural history which is doubtless well known, for as my memory serves me it is mentioned by Darwin; and I have myself repeatedly seen butterflies crossing the Red Sea with considerable rapidity in the very teeth of a decidedly stiff breeze—I think, from memory without notes, that I may call it a reef topsail breeze, a breeze such that one expected every moment to see a form like a butterfly's carried away helplessly before it. And yet the butterflies had evidently started on their migration with a consciousness of power to battle with the opposing breeze, had already accomplished two-thirds or more of their journey, and were continuing their course with no uncertain rate of progress from the east to the west shores of the Red Sea. Taken in this connection, the fact kindly shown me in the British Museum that certain patches on the east and west shores of the Red Sea are the habitat of the same butterfly is noteworthy. The structure of the butterfly prepares us to expect that it would be liable to be tossed about by any wind that blows, rather than that it would be able confidently to adventure a passage of several miles in the very face of it, and across a sea where it could never alight to rest. With this example before us it seems to me that we must exercise much caution in accepting as conclusive the general presumption that the larvæ of oysters are borne by the currents. I should rather lean to the conclusion that the balance of probabilities is in favor of their being able to

direct their own course in accordance with their instincts. But whether this be so or not, and whether the currents are also factors in their distribution, it is well to note that Franklin's Chart of 1838–1845 says of the Gulf of Manaar "the current is generally with the wind, but in May and October becomes very variable," and May we have seen is one of the spawning months, so that variety of superficial current, if a factor, would account for widened distribution.

So far then, or while in the larval form, there would seem to be no marked difference in the habits of the young of the edible and of the pearl oyster. It is from the time that they are precipitated as spat that the difference commences, the pearl oyster having migratory powers, as we shall see in connection with its foot, its byssus, and its shell.

The Foot.

The edible oyster, from the time when it is precipitated as spat, is immovably cemented for life to rock, if it chance to fall on rock, or if it fall on mud, lies, by its weight, helplessly on its heavy convex side; and in consequence of our pearl bearer having been commonly called an oyster, the mind is prepared to expect the same of it, but it has a locomotive organ in what must be called a foot, like that of the *gastropods*, with which it walks with ease. Remembering that our pearl bearer [*Avicula* (*meleagrina*) *fucata*] is a mussel, we note, in Tryon's Structural and Systematical Conchology, that like movement has been recorded by Dr. Lockwood of an American marine mussel, *Modiola plicatula*, which, "when placed in an uncongenial position, can use its foot in escaping with as much facility and in the same manner as a gastropod, not only traversing a part of the bottom of his aquarium, but actually gliding up its perpendicular wall to a distance of six inches," and "the river mussel drags itself slowly along by protruding and contracting its flexible foot." But we have to do with an animal

that has idiosyncrasies to be separately observed, and I see from my notes taken on the spot that my observations of the pearl oyster were as follows:—

Having desired that some live pearl oysters might be procured for me for the purpose, and some being brought to me accordingly after dark, I remembered that they are said to be most active at night, and, putting them into a thin blown-glass soda-water tumbler full of sea water, brought a bright reflector and another kerosene lamp close to it on the table, so that I might get an excellent light, and with a good hand magnifying glass settled down to prefer their evolutions to dining, which I did closely for two hours, till the eyes, &c., ached beyond further endurance.

One young pearl oyster, measuring by compass $\frac{7\frac{1}{4}}{16}$ths or, say, $\frac{15}{32}$nds of an inch from hinge line to contour diagonally, and having two others of nearly its own size attached to its shell by their byssi, walked up the smooth side of the glass 4 inches in 8 or 9 minutes. I could not time with closer exactitude, because I did not like to take my eyes off the oyster to look at my watch, lest on arriving at the surface the animal should throw out a byssal thread, and I should miss seeing it done. Thus the rate of progression, though perpendicular, though on a smooth glass surface, and though the animal was weighted with two other oysters, making an addition of more than one-and-a-half times its own weight, was at about the rate of an inch in two minutes. Another osyter measuring $\frac{6}{16}$ths of an inch across, which I timed exactly, maintained the same speed, covering 3 perpendicular inches by compass in 6 minutes.

The water in which the young oysters were brought me being somewhat turbid, I supplied them with water fresh from the sea, which was so clear that one could distinctly see living *diatomaciæ* in it, and what seemed to be *rotiferæ*, but were probably pearl oyster *larvæ*, as well as a minute trans-

parent vermiform insect moving in the *fucus* growing on the shells of the oysters. I had also taken the precaution of covering the mouth of the tumbler with a dinner napkin, so that the heat, motion or odour of the lamps, the air, the breath might not affect the natural movements of the animal.

The foot, when contracted in spirits, is seen under the microscope to have a median groove throughout its length; but I must confess that the animal had been abruptly introduced to spirit of full strength and not to gradually strengthened spirit. When spread out, however, as it was when adhering in life to the glass in the act of walking with the sole towards me, and only a very thin glass intervening, I made the foot out to have three suctorial disks, answering seemingly to the *propodium*, *mesopodium*, and *metapodium* of the *heteropoda*, with the median groove apparent only between the anterior (*propodium*) and mid sucker, and the mode of progression was this :—While the two posterior suckers adhered, the anterior advanced by stretching itself out, adhering as it went by both sides of the groove till the anterior sucker took a hold; then the mid sucker was loosened and advanced, the anterior and posterior suckers and the shell being stationary the while, till the mid sucker got a hold nearer to the anterior sucker ; then the posterior sucker loosened its hold, the whole shell was given a sudden lift, the space between the mid and posterior sucker was contracted, and the posterior sucker took a fresh hold closer to the mid sucker. The foot was merely contracted as in the body of a worm, not brought together in a loop as in a leach. Then the process was repeated and the animal moved steadily up the smooth glass, with its burden of two other oysters on its shell, till it got the point of its *umbo* (beak) level with the surface of the water, and there it rested adhering by its foot alone without any shred of *byssus*. After a little time I agitated the water with a fork so as to try and wash it off; I even touched the shell gently with the fork, but the animal

held its foot-hold firmly, and without any *byssus*, till I forcibly pushed it down with the fork. Then in falling, free of the side of the tumbler, it made some effort by which it regained the side of the tumbler before it had fallen half-way, and immediately resumed its walking ascent till it reached the surface. I forcibly dislodged it three times, always with the same results—a quick movement to the side, and an immediate march to the surface. When I left it in peace at the surface, it began to feed off its own shell-borne commissariat, of which more hereafter, forcibly ejecting what was passed or ejected, but still without a *byssus*. During the two hours of observations no *byssus* was thrown out, and early the next morning I noticed that still no *byssus* had been formed by oyster No. 1; oyster No. 2, which was attached by its *byssus* to the shell of No. 1 while these observations were being made over-night, and which had then been striving in vain to reach the glass with its foot, having at length succeeded, in the course of the night, in gaining it, and thereon marched upwards till it got its own *umbo* level with the surface, and that of No. 1 clear out in the air, and so No. 1 was by the *byssus* of No. 2 held in a position in which neither its foot nor *byssus* could reach the glass. It was very clear to my mind that the animal used its foot, and its foot only for walking, and also for being temporarily stationary, and that the *byssus* was not put forth till the animal had reached a position in which it was content to stay more than temporarily. The foot, too, seemed to be capable of being used as a natatory organ, in which it is again like the *heteropods* or swimming *gastropods* (water-snails). In this connection I may mention in passing that I noticed a round opening in the sole of the foot, and immediately anterior to the *mesopodium* which is said to be the opening of the pedal aqueous system common to many gastropods. No. 2 was the smaller pearl oyster of the two,

measuring $\frac{6}{16}$ths of an inch across, while No. 1 measured $\frac{7\frac{1}{2}}{16}$ths.

The sole of the foot was nearly white, the upper part was mottled light-brown of the same color as the shell of the animal, which in this instance was sandy.

Dr. Kelaart gives the length of the foot of a mature oyster as 2½ inches when distended in use and 1½ in rest. The breadth of the shell of a mature pearl oyster from hinge to contour is, I may add, about 3 or 3½ inches. In my young oysters the length of the foot and breadth of the shell were the same, indicating, *quantum valeat,* that the foot of the young oyster is larger in proportion than that of the old oyster, in consonance with greater migration in youth than in maturity; and the young are said on all hands to be more active than the old oysters.

The thinness of the glass tumbler and the excellent light greatly favored my observations.

The persistent striving of these oysters for the surface seems to indicate that while occupying the bottom of the sea they prefer to be sufficiently raised from it by rock or other substance to be free from the wash of sand; accordingly we find they cluster on rocks 4 and 5 feet off the bottom and even climb the chain of a buoy.

The foot, then, indicates the migratory habit of the pearl oyster, and especially in youth. We shall see that the *byssus* and the shell also point in the same direction and with the same limitation.

We may note, however, before bidding adieu to the foot, that it is also used like a hand for directing the point of attachment of each thread of the *byssus.*

The Byssus.

The very presence of a byssus is again another indication of a transitory as distinguished from the permanent cemented

hold for life of the true oyster (*Ostrea*). The *byssus* is formed of a number of separate threads thrown out one by one and cemented to the rock or other hard substance each thread separately at its tip which is a flattened oval and the several threads are so directed by the animal that the hold may be spread. Being thus spread out into separate threads at the end furthest from the animal, the byssus converges into one cable before union with the animal. Each thread which goes to make up the cable being necessarily thrown out from the animal, the cable end is at first weak, and strengthened as the number of threads is increased. These are multiplied at will according to the necessity of the animal, as few as eight or ten being noticed on one, and as many as fifty on another. Once having cemented the spatulous end of a thread of the byssus, the pearl oyster is not capable of withdrawing that thread, it can only shed its whole byssus at the point where the cable end of it is attached to the animal. Whether it sheds its byssus, or the byssus is forcibly torn out of it, or the thread ends are cut, the animal is capable of forming a new byssus. It is a common thing for the threads of the byssus to be bitten through by shrimps or crabs, and no clump of young pearl oysters can be taken up from the sea without exhibiting on their shells the shed and cut *byssi* of their brethren that have been attached to them, and the shed *byssi* and those that have been forcibly torn out by the root are readily distinguishable from those that have been cut by crabs, &c. The fact that the young shed and reform them more often than the old indicates that they are more migratory at that age than when older.

I have again and again applied prolonged steady tension, and also in different directions, to see if any single thread would yield its hold, but it is evidently cemented so that it *cannot* let go. If it could let go, it would surely do so and withdraw itself into its shell before suffering itself to be

bitten through by a crab or shrimp. This cementing of the end of each fibre is seemingly a provision to allow of the animal being at rest while adhering to the rock, no undulation dislodging it that cannot tear it limb from limb; and that the wave could hardly do, for the surface of shell to be acted on is limited, and the power of throwing out extra threads is practically unlimited, one oyster having as many as fifty at a time. The strength of the *byssus* is also not insignificant. Testing it with a spring balance, I found that a young oyster measuring only $1\frac{2}{8}$ths of an inch along the hinge line and $1\frac{3}{8}$ths of an inch from hinge line to margin withstood steady tension till it reached $2\frac{3}{4}$lb. when the *byssus* came away at the root. Others of about the same size yielded at a tension of $1\frac{1}{2}$ and 2 lb.

I conclude that a pearl oyster is not likely to be dislodged by the force of wave action or current, and that, if it moves, it moves voluntarily.

The Shell.

The peculiar formation of the shell alluded to above merits close attention, and affords confirmatory evidence of the migratory habits of its tenant. Referring to the irregularly concentric circles of regularly radiating flattened overlapping spines, we must consider first the object of their formation, and then the object of their retention.

It will be remembered that the mantle, which it is that secretes the shell, is the part of the oyster which is nearest to the contour of the shell, the thin darkly-colored membrane which lies between the shell and the *branchiæ* or gills, which are a specialized portion of the mantle, and are commonly known in the edible oyster as the beard.

Bearing in mind that the shell of conchifers is merely the outward expression of the animal it contains and protects, the external skeleton not distinct from, but incorporated with, the animal by being covered with an epidermis; bearing in

mind that the shell is no fortuity, has no separate growth or existence of its own, but dies when the animal and epidermis die; bearing in mind that it is formed by the mantle, each layer of it having once been a portion of the mantle successively calcified (or hardened with carbonate of lime) and thrown off by the mantle to unite with the layers previously formed; remembering in *murex* the marked projections (*varices*) are the lips of former mouths, the very presence on the shell of the young pearl oyster of the flattened spines above mentioned at once refers one to the mantle as calculated to have a similar formation. Accordingly we find Dr. Kelaart writing of the mantle as having tentacles consisting of "a series of long and short flat filaments, the long ones having lateral filamentous projections," and I observe myself, under the microscope, that the mantle is thus digitated. According to the law of formation of shell, then, these flat projections of the mantle must have formed the flattened spines; and the question arises whether the spines were secreted for the protection of the digitations of the mantle, or the digitations existed for the purpose of secreting the spatulated spines.

Dr. Kelaart suggests the theory that these flat projections of the mantle serve as tactile organs so keenly sensitive as to be equivalent to sight. It may be that they do, but still it is left unaccounted for why they should differ in form from the equally sensory mantle margin of the edible oyster in being flat and projecting instead of uniform in contour. And, if no special reason can be assigned for this their peculiar deviation in form, one may be permitted to infer that the peculiar formation of mantle exists for the purpose of forming the spines, rather than the spines for the sake of protecting the mantle. Again, if the spines existed only for protecting the flat projections of mantle, one would expect to see them disappear after they had discharged their office, as "in most cases marginal characters are absorbed away by

the animal before commencing a new growth of its shell" (Tryon's Structural and Systematic Conchology). Seeing that they do not follow the common law in the secretion of shells—the law that what is no longer required is absorbed for utilisation in the new formation—but are retained in great numbers and well ordered regularity, one is led to conclude that it is for a purpose that they are retained, and to conjecture what that purpose may be. Obviously armature cannot be the object, for that could be better served by making the spines round and sharp and needle-like, as in *Cytherea* (*Dione*) *lupanaria*, Desh. Looking again more closely at a shell fresh from the sea, we find that there are not only projecting spatulated spines in about twelve marked radiations, but that between them are shorter spines, and after them they fine off to lesser radiations in the direction of the two ears, and along the base of all runs a thin foliation projecting slightly from the shell, so that at every new formation of shell, and these are at very close intervals, there is a thin knife-like ledge running all round the former contour of the shell and projecting slightly with further projections from it in short and long spines.

Here we may recall what Dr. Kelaart writes:—

"I have through the microscope ascertained the kind of food "pearl oysters live on. This consists of minute *algæ* or weeds, "animalcules and shells, called foraminifera. *Diatoms* also, "those minute vegetable forms which can scarcely be detected "with the naked eye, are found growing on the external surface "of the shell, where a host of infusorial and microscopical "objects likewise find a pasturage, so that the oyster may be "said to carry on its back the food on which it lives."

For my own satisfaction, I have confirmed these remarks by personal observation; and it struck me that this was the primary purpose which the formation of the outside of the shell of the young oyster was intended to serve. The numerous projecting spines presented a surface admirably

adapted for giving holding ground to facilitate the growth of minute algæ, while the fine interstices between the closely overlapping spines and the continuous crevice under every flange afforded with the algæ, the most beautiful shelter for infusoria. Seeing then that the young oyster is in every individual studiously provided with a shell specially constructed both for sheltering the food of the young oyster and for rearing the food of that food, it seems to follow that it is a great and primary necessity to every young pearl oyster to be thus independently supplied with a moveable commissariat, and it indicates that to have such a necessity a migratory habit must be cne of the laws of its existence. In brief the testaceous covering indicates the habit of the tenant.

It may serve to give us a clue in a further direction also. The spines present on the shell of the young pearl oyster are locally said to be absent from the older oyster. On this point I have had no opportunity of making personal observations, for as I have said we came on no mature live oysters, and no reliance could be placed on dead shells that might have been subjected to abrasion; and the shells kindly shown me in Ceylon had all been rubbed smooth by way of cleaning. I note here that Reeve's Conchologia Iconica has the remark: "as the shell advances in age and the valves thicken the sculpture becomes obsolete." This remark is made of the giant pearl bearer *Avicula* (*meleagrina*) *margaritifera*, the shell of which is 7 inches across from hinge to contour, and can only be taken *quantum valeat* as confirmatory of the local opinion of our *Avicula* (*meleagrina*) *fucata*, which is only 3½ inches across at maturity. Presuming that the local information is accurate on this point, and as opportunity occurs of examining mature oysters, it is to be hoped that it will be tested, it seems to indicate the conclusion that there comes an age when, from the increased thickness and weight of their shells, pearl oysters cease to be

migratory and therefore cease to require the provision of a portable commissariat store. And what is the age at which this change of condition supervenes may seemingly be discerned from the presence or absence of the spines and foliations. I note that in the first year they begin to disappear from the region of the *umbo* ; but they were plentiful on the remainder of the shell of oysters said to be 18 months old, and I saw no live ones older than that. On the other hand, however, the reason for the spines and foliations with the vegetable growth and insect life reared thereon being continued near the margin of the shell after disappearance from the umbo may easily be supposed to be that only near the margin could it be of direct use to the oyster, because only from near the margin could food be drawn into the mouth of the oyster by the current which it creates for the purpose.

If pearl oysters carry on their two sides thickets of algæ affording, with the formation of the shell, harbour for *diatoms*, animalcules, &c., and the harbour increases with the growth of the animal, and a diatom frustule produces a thousand millions in a month, the pearl oyster should not have to compete, as the English oyster is said to do, for food, but should have always an ample store if only the water will remain clear enough for it to be continuously feeding. But possibly varying depths affect the growth and fertility of the algæ and diatoms—that is a further question. For the English oyster tides are said to be useful in bringing food to the foreshores ; but our Indian pearl oyster grows his own food and only wants still clear water wherein to feast upon it. The abundance of food seems to be further deducible from the fact that we find the pearl oyster not in a single layer, but frequently piled up one over another, the lowest clinging by its byssus to the coral rock or other hard formation and the one above it clinging to the shell of the one below it, and another clinging similarly

to the shell of the upper one, the third one having again another adhering to it.

Migratory habits.

Thus we trace in the larval form, in the foot, in the byssus, and in the shell indications of the pearl oyster being migratory, markedly so in its earlier stages, and decreasingly so with age ; and the further questions are, why it should migrate, and whither. The first migration as *larvæ*, as many as twelve millions to a parent, is possibly more or less involuntary ; and the countless myriads provide, by the law of chances, that some at least shall fall on favorable spots, as well as leave a margin for destruction by the enemies of the oyster. The subsequent migrations must be voluntary to escape from uncongenial surroundings. What these incongenialities are we may in a measure conjecture from the similitudes of the edible oyster.

The Spat.

Lest we should be again misled, it is necessary to allude to a mistake which has obtained with reference to the spat of our pearl oyster. The spat of *Avicula fucata* is, when small, almost flat, the valves being exceedingly thin, with scarcely a perceptible concavity. They are, also, the exact color of their surroundings. Consequently, they have always escaped observation, and the native divers frequently finding the oyster beds covered with innumerable minute shells that bore an approximate resemblance to the pearl oyster, confidently concluded them to be the spat of the pearl oyster, and when these minute shells were followed in the course of time by growing oysters it was not unnaturally concluded that they had grown from spat to oyster, the more so as the true spat, from being thin and the color of its surroundings was not seen. And this mistake of the divers was, unfortunately, accepted and stereotyped by a plate in

"Sketches of the Natural History of Ceylon, executed from "drawings made for the official inspector exhibiting the "ascertained size of the pearl oyster at every period of "its growth from the 'spat' to the mature shell." And with a well-drawn plate by Sowerby issued under such authority it is not surprising that eminent naturalists following accepted without hesitation that the minute shell in question was the spat of the pearl oyster. Captain Phipps, Superintendent of Pearl Fisheries at Tuticorin, had however his doubts, and expressed and maintained them in the face of the long list of high authority to the contrary. He was good enough to show me these minute shells, and there is no doubt they are the shell of *Avicula vexillum* (Reeve,) a shell that in maturity attains only one quarter of an inch in length. The largest shell that I have ever seen out of several hundreds, if not thousands, measured $\frac{4\frac{1}{2}}{16}$ of an inch. Naturalists were further confirmed in considering these minute shells to be spat of the pearl oyster by observing that their shell exhibited under the microscope the same prismatic cellular structure as the shell of the pearl oyster. But we have the authority of Carpenter for that cellular structure being common to most of the *Aviculæ*.

These minute shells of *Avicula vexillum* which have so long been taken for the spat of our pearl oyster, *Avicula fucata*, may be seen side by side with *A. fucata* in the British Museum at South Kensington, and in the Government Central Museum at Madras. Closely examined side by side it will be observable that *A. vexillum* is very much more convex than *A. fucata*; is more oblique; has the ear on the sinal or short side not produced in an almost straight line, but rounded off; has the right valve fitting deeply into the left valve, whereas in *A. fucata* the two valves lie very nearly flat against each other. *Avicula vexillum* has again not a trace of the numerous spatulated spines with which the young of *A. fucata* is always covered in regular circles, and it has distinctly

different flanges, and no *algæ* adhering to it. And it has the umbones more anterior or advanced beyond the hinge line. It is colored differently, dark lines radiating from the convexity to the contour; and its habit is different, in that it adheres to weed, while *A. fucata* affects rock.

Further to facilitate the observation of the difference in the form of the shells the minute *avicula vexillum* which attains only a quarter of an inch in breadth has been photographed and magnified to the size of *A. fucata,* when the differences are emphasised and observable beyond dispute.

Furthermore, any lingering contention that such changes of form are referible to development is effectually disposed of by the discovery of the true spat of *Avicula fucata* at an age when it is much smaller than a quarter of an inch across, and it has markedly all the characteristics of a half-grown pearl oyster. If it differs at all from its half-grown form it is in having the spatulated spines comparatively more expressed, and the slight convexity still slighter in comparison, so that in both respects it opposes itself to similitude with *Avicula vexillum.* I have seen them alive and have them in spirits of progressive sizes from one-twelfth of an inch from hinge to contour rectangularly to half an inch, and after that the connecting progress is easy to trace, and the very smallest had all the characteristics of a pearl oyster of a year old from the prismatic cellular structure of the shell, down to the spatulœ foliations and algæ thereon.

The Age.

The age of the oyster is considered a matter of some practical importance, because it is held that our pearl oyster lives for 7 years and then dies, consequently that the fishery must be conducted before they die, or the pearls will have dropped out with the dead decaying animal. It is also held that the pearls are too small to be worth taking till the fish is more than 4 years' old, so that when a Superin-

tendent of Pearl Fisheries comes on a bank of oysters he has to determine their age and therefrom to decide when it will be remunerative to fish the bank, and to advertize the fishery and make all his arrangements for temporary buildings, an extra body of Police guards, divers and boats and Superintendents, &c., &c., &c., all well in advance. If he fishes the oysters a year too late he may lose them all, if a year too soon he will realize but small results by reason of the pearls being too small to command good prices. Therefore much stress has been laid on the age of the oyster, and the native divers profess to be experts at telling the age. Under normal conditions they doubtless are so, but there are circumstances to be taken into consideration which they do not allow for. For instance they are wrong about their starting point, always having mistaken *Avicula vexillum* for the spat of *Avicula fucata*. But allowing that they have bridged that initial error by a very fair guess, then comes the point that they do not allow for individualities of growth, and rapidity of growth seems to turn with oysters, as we know it does with fish, on the favourableness of the surroundings. Thus we know that out of the same hatching of salmon some will descend to the sea a whole year later than their twin brethren. And trout in one lake or river run very much larger than in another, and even in the same river the best holts yield the best fish. It is not unnatural that oysters should follow the same rule. Accordingly, we find in clusters of oysters considerable variation in size, and yet hardly enough to say they belonged to different spattings, though it was contended before me by the divers that of the oysters found on the Tholáyiram Pár (bank No. 30) some were one year, some a year and-a-half, some two years old. They had doubts, however, in their own minds. Seeing that all the oysters in one bed would seem to be under more or less approximately similar conditions, one would not expect to find the variations in

growth very great; but when the circumstances are altogether different as in the case of an oyster attached to a buoy, one naturally expects to find a very marked difference in the health and growth of the animal. But when the differences in the surroundings are less marked, we expect to find the effect on the growth correspondingly less marked also. Thus in a bank of oysters we find that those which have contrived to get by themselves are larger than those that are thickly clustered, and in such cases the variations in growth are naturally variations of degree, such as might easily account for the difficulty the divers experienced in ageing all individuals. It is interesting also to observe that any individual oyster that is growing more rapidly than its fellows has the soft edge, which is the growing edge, longer in comparison than the soft edge of a slower growing neighbour, the shells of some of the most backward of which are stunted. It is a very natural indication of varying rapidity of growth, which I also have observed in a less degree in the horn of the antelope, though there the case is more complicated than in the oyster. Again, we find that the system of ageing pursued on the two sides—the Ceylon and the Madras sides—of the Gulf of Manaar differ, and we are hardly justified in jumping therefrom to the conclusion that the whole set of divers and the experienced Superintendent on either side is in error. Once more we find that the same oyster on the Ceylon side grows at maturity to a decidedly larger size than any to be found on the Madras side, which is an indication that the conditions of life are more favorable to the oyster on the Ceylon side than they are on the Madras side, and, taken in connection with the different rate of ageing on the two coasts, another indication to be added to the several instanced above that the rate of growth of the pearl oyster varies with its surroundings. Indeed it would be strange if such a widespread rule did not obtain in a greater or less degree. Allowing then for its

obtaining and allowing also a margin for our ignorance as to the exact limits within which it obtains, it seems not wise to rely much on any rule of age, but rather to lift a sample of oysters every six months and to examine the size of the pearls they yield.

There is yet again another reason why it is more prudent to be guided by actual investigation made every season than by any general rule of age. This lies in the belief that as its reproducing powers weaken with age the oyster absorbs and re-utilizes, for other purposes, the very pearl which it had thrown out in the vigor of its youth and middle age. This subject will be again referred to when remarking on the formation of pearls.

Signs of Age.

The practical test of the oyster having reached an age at which it is ready to be fished is, firstly, its having attained the full size of 3½ inches rectangularly from hinge line to contour. Then the divers feel the edge of the shell, and, if it is pliable and will break off in the fingers, the shell is still growing and the oyster is too young. Having reached maturity, the signs of increasing age are increasing thickness of shells, and lastly, a V-shaped gape at the hinge. When this is deep and wide the oyster is near its term of life and the fishery cannot be delayed. Gaping at the umbones is a mark of age in all bivalves. But these are only approximate guides; and where it appears from them that the oysters are mature the time has arrived when the growth of the pearls should be periodically tested by lifting and examining a sample of oysters every six months.

The Formation of Pearls.

Like other molluscs the pearl oyster coats the interior of its shell with a smooth substance called Nacre. This it does for the purpose of protecting itself from friction with uneven-

ness in its own shell, and if any foreign body which causes friction finds lodgment in the pearl oyster it coats it also, in self-protection, with this same Nacre. So sensitive is the animal of the least friction that it cannot endure the presence of even its own microscopically minute ova without coating them with Nacre. These ova which have escaped by rupture from the over-distended ovarium of the parent pearl oyster, and the ova of Filaria, of Circaria, and of three other parasitic worms, form, when coated with Nacre, the valued pearl of commerce. When first covered they are so exceedingly small as to be valueless seed pearls, but coating after coating of Nacre increases their size, and so the pearl continues to grow in size as long as the oyster is in vigorous health, and the varying size of pearls probably depends, as in the varying size of stags' antlers, on the vigor of the individual oyster. But it is a pretty general rule with shell-fish to absorb or re-utilize portions of their own shells that can be thus advantageously economized, and following this rule it is believed that as the reproducing powers of the pearl oyster wane with the failing vigor of age, it falls back on its own pearls for a supply of Nacre, and absorbing it utilizes it in fresh places in economy of the labor of producing fresh Nacre. And thus it is believed that there comes an age in the oyster when the pearls not only cease to grow but actually diminish in size.

Their form depends on the accident of the form of the foreign body coated. If the foreign body be a single ovum, then the pearl following its form is of sequence perfectly round, but if the nucleus of the pearl consists of a number of ova, then the form of the pearl is necessarily irregular, and when by such accident of origin the pearl assumes the form of a pear it is most highly prized in the market. When the Nacre is deposited over sand adhering to the shell the pearl becomes an excresence on the shell, and is called a blister pearl. Such pearls are ordinarily very much larger than any others, but their iridescence is inferior and they have only

one good side and have to be chipped off the shell. They therefore command but a low price.

The lustre or "water" of the pearl is due entirely to the action of light, and is dependent consequently on the Nacre being of a character to reflect light to advantage, and it is in this quality that the Nacre of the pearl oyster of the Gulf of Manaar excels all others, and it is for this reason that the pearls of our *Avicula fucata* are considered superior to all others in lustre. Probably the Nacre is laid on in thinner more translucent coats than in other pearls, and the lustre or so-called "water" may in some measure be due also to the clearness of the sea, for in fresh water pearl bearers, the presence of iron in the water imparts to the pearl an obvious red tinge. The iridescence of fish scales is referrible to the same cause, to wit the reflection of light from innumerable minute angles, and the cause being known like effects have in a less degree of excellence been reproduced in manufactures.

Though Nacre is correctly called the mother-of-pearl, it is not by our pearl oyster *Avicula fucata* that the mother-of-pearl of commerce is yielded. *Avicula fucata* is not large enough, nor is the Nacre thick enough to produce the buttons and knife handles of commerce, and it is to the giant pearl oyster, *Avicula margaritifera*, that we have to look for that purpose, though in consequence of the name *A. margaritifera* having by many authorities been applied to our *A. fucata*, *A. fucata* is wrongly credited with producing mother-of-pearl. This error of name has been made and adopted on so many able hands—not a few of them authorities entitled to marked deference—that I naturally hesitated long before presuming to conclude that not a little confusion has arisen from treating *Avicula margaritifera* and *A. fucata* as one and the same animal. The shell of the former is 7 inches across, that of the latter 3½ at maturity.

Enemies of the Pearl Oyster.

A word may be said in parting on the enemies of our pearl oyster. Foremost among these in all official reports has ever figured the dreaded "Suram," which is the Tamil name for a *Modiola*. Its habit is to make by agglutination a regular blanket of triturated shells and sand, with which a colony of *Modiola* seems to cover and smother the young oyster. If they are found mixed with young oysters of less than one year old the death of the whole bed of oysters is reported to be the invariable result. Whereas, if the oysters chance to get a clear year's start of the *Modiola*, they are not troubled by them, from which it would seem that the oysters are then old enough to live upon the minute ova and larvæ of the *Modiola*. The same inference would seem to be indicated by the fact that in a bed of half-grown oysters *Modiola* are not present, though they may still be found round the edge of the oyster bed, where they have escaped being consumed by the oysters. Thus it would seem that like many an analogous position in nature the *Modiola* might in man's hands be made the friend and feeder of the pearl oyster rather than its enemy, that is to say, if Pisciculture is ever permitted to become a practical science in India. The minute ova of the *Avicula vexillum* probably form in like manner a large element in the food of the pearl oyster.

Next among the reputed enemies of the pearl oyster prominence has been given to *Turbinella rapa*, which is the chank or holy shell of the Hindus, but *Turbinella rapa* affects rather the muddier sands which yield the worms on which it chiefly feeds, and though stray individuals are sometimes found on the sand patches among the rocks affected by pearl oysters, they have no means of injuring the live shell-encased pearl oyster. Though it must be admitted that two Superintendents of Pearl Fisheries aver that they have seen *Turbinella rapa* eating an oyster, I hold that *Turbinella rapa* was only eating an already dead oyster, in accordance with the

remark in Tryons' Conchology "Muller has seen *Cerithia* . . . . bored by *Murex Senegalensis*, in consequence of which the animal dies and opens its operculum, when a *Turbinella* comes to share the feast." In this connection it may be noted that on the Ceylon side of the Gulf of Manaar the *Turbinella* is not fished, and is consequently in much greater abundance than on the Madras side, where it is regularly fished, and yet the Ceylon pearl fisheries suffer no injury therefrom.

Fasciolaria trapezium, Lamark, which is also called a chank by the natives, is fortunately much rarer and has consequently not attracted so much attention; it has however a labial ribbon armed at its tip with rows of glistening lancets with which it can bore through a thick shell, and another chank which is seemingly *Murex trapezium*, Lin., is said by the divers always to clear a space around it by destruction of the oysters, a reputation which I have had no means of testing.

The Trigger Fish.

The trigger fish, so named from the trigger-like second ray of its first dorsal fin, and called also the file fish, or leather jacket from its rough exterior, is said to be another enemy of the oyster. The fishermen say there are three of them in the Tuticorin seas. The one shown me was *Balistes mitis*. The fishermen say they eat mainly *Modiola*, and congregate wonderfully on the beds of these small mussels, and never attack any but the very young oysters; and to this agreed the teeth and the contents of the stomach of the one full-sized individual I was able to examine. The teeth, though sharp, were not strong, and were easily displaced by a penknife. The intestine contained chiefly shells of *Modiola* and no oysters that I could detect, and no shells of any thickness. Doubtless they do eat young oysters on occasion as do all rock fish, and Captains Phipps and Donnan have found shells of young oysters in them, but their favorite

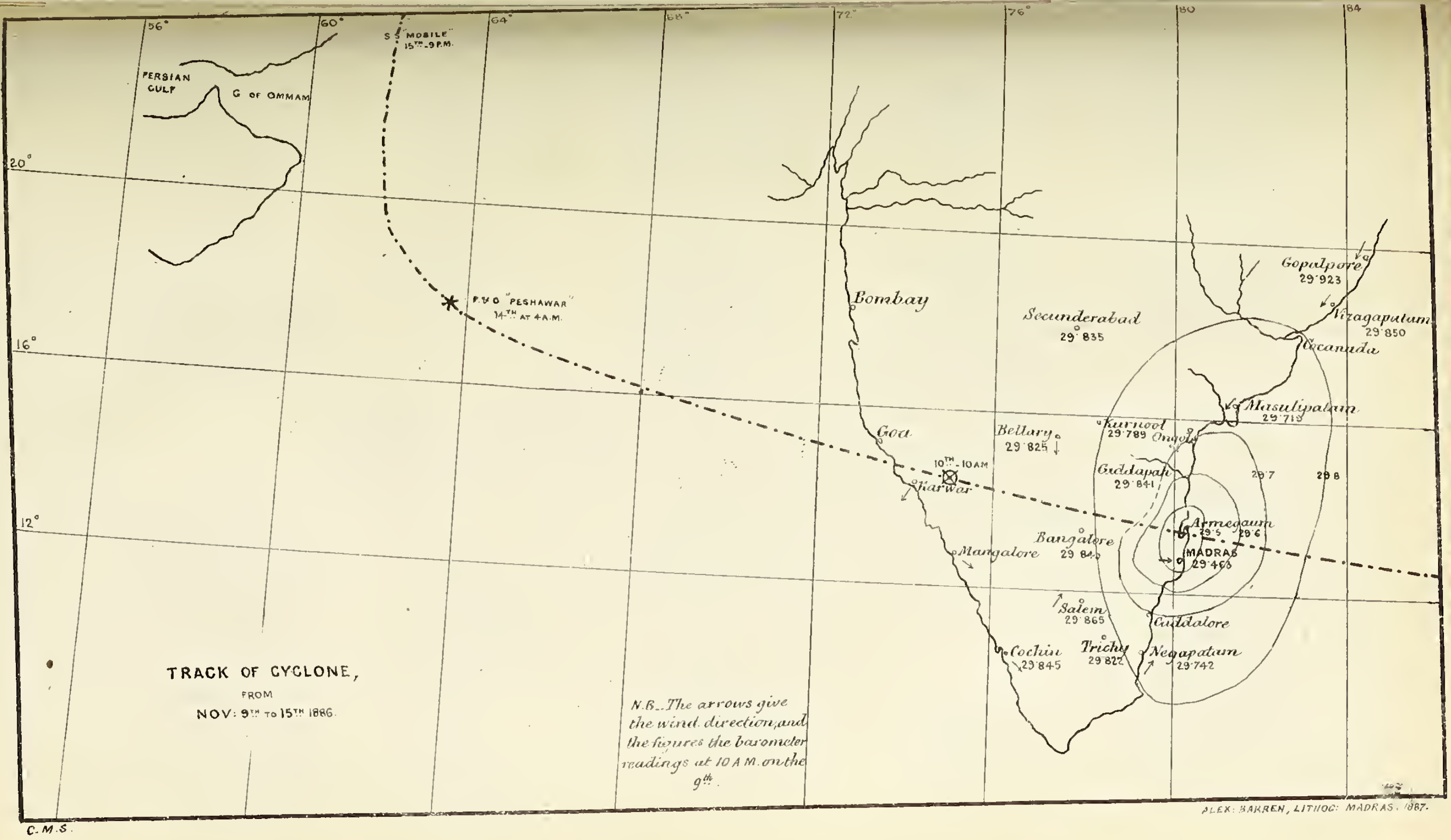
food is the *Modiola*, one of the worst enemies of the oyster; so they themselves are more friends than foes to the oyster.

Rays.

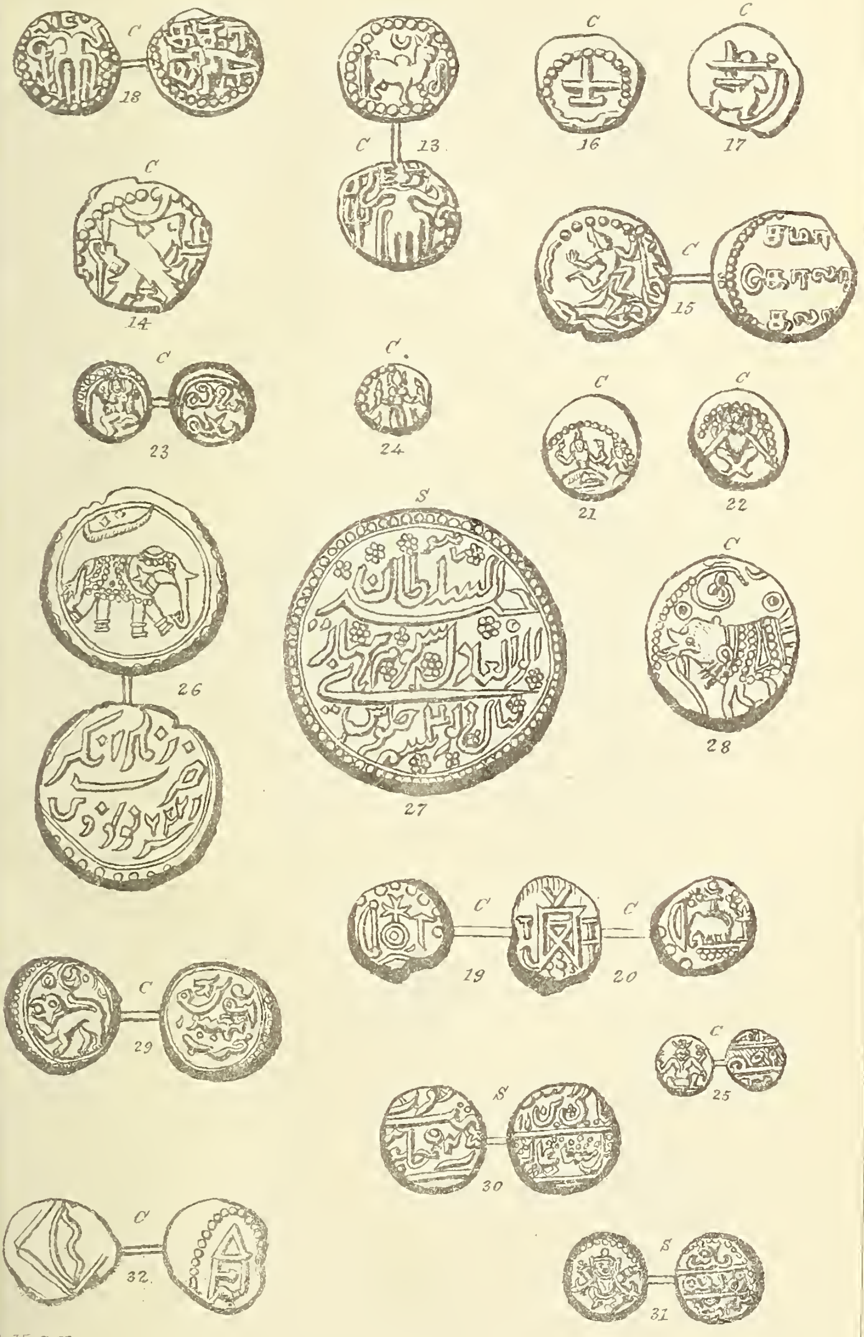
Rays are a very different class of enemy. Of the several sorts said to infest the oyster banks, the one shown me was *Trygon uarnak*. The divers feared them as enemies of the oyster more than anything, and deprecated their visits with remarkable earnestness. The short thick teeth are exceedingly powerful, and capable of crushing a full-grown oyster. I saw the shells of *Turbinella rapa* that had been bitten right across the body whorl, where there was a thickness of solid shell of $\frac{1}{4}$ inch in some, in others of $\frac{5\frac{1}{4}}{16}$ of an inch, and that too disposed in the strongest form, that of an arch. The flatter thinner shell of the oyster would yield much more readily. The fishermen informed me that rays are not always present on the banks, but come in by shoals from the deep sea with the south-west monsoon. They are also on the banks during the fishing, and the larger ones are sometimes mistaken for sharks and frighten the divers. Though their teeth argue destructive capabilities, I should have preferred to learn their actual habits from the contents of their stomachs before endorsing the verdict against them.

The native fisherfolk knowledge is remarkably good, and should never be neglected, but at the same time *always tested*, for it is the accretion of ages not altering with the times. For instance, they hold firmly to this day the belief that had encrusted into a myth even in the days of Pliny that the pearl is formed by the oyster coming to the surface at dawn and taking in a drop of dew with the sun's rays on it—about as correct as " around thee shall glisten the loveliest amber that ever the sorrowing sea-bird hath wept."

BRITISH MUSEUM
TRING
MUSEUM
NATURAL HISTORY


TRACK OF CYCLONE,
FROM
NOV: 9TH TO 15TH 1886.
N.B._The arrows give the wind direction, and the figures the barometer readings at 10 A.M. on the 9th.
PERSIAN GULF
G OF OMMAM
S.S "MOBILE" 15TH - 9 P.M.
P.&O "PESHAWAR" 14TH AT 4 A.M.
10TH - 10 AM
Bombay
Goa
Karwar
Mangalore
Cochin 29·845
Bellary 29·825
Secunderabad 29·835
Kurnool 29·789
Ongole
Cuddapah 29·841
Bangalore 29·84
Salem 29·865
Trichy 29·822
Armegaum 29·5 29·6
MADRAS 29·466
29·7
29·8
Cuddalore
Negapatam 29·742
Masulipatam 29·719
Cocanada
Vizagapatam 29·850
Gopalpore 29·923
56°
60°
64°
68°
72°
76°
80
84
20°
16°
12°
C.M.S.
ALEX: BARREN, LITHOG: MADRAS. 1887.

Plate, 2.



R.H.C.T.

BARREN; LITHOG: MADRAS, 1866

Fig. 5

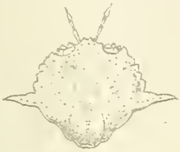


Fig 6.

Fig. 1.

Fig: 2.

Fig: 3.

Fig: 4

LEX. BARREN. LITH. MADRAS 1887

MADRAS SPECIES OF MATUTA.